PB-228 156

# COMMUNITY WATER SUPPLY STUDY. STATE OF VERMONT. STANDARD METROPOLITAN STATISTICAL AREA

Floyd B. Taylor, et al

Bureau of Water Hygiene
Boston, Massachusetts

3 April 1970

DISTRIBUTED BY:

NTIS
National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

PB 228 156

# NATIONAL COMMUNITY WATER SUPPLY STUDY

## STATE OF VERMONT

Reproduced from
best available copy.

by

Bureau of Water Hygiene

Environmental Control Administration

Consumer Protection and Environmental Health Service

Public Health Service

DHEW Region I

1970

1<

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
U S Department of Commerce
Springfield VA 22151

107

## Table of Contents

Page

Forward

Summary of Findings and Conclusions 1

Recommendations 22

Introduction

Purpose and Background 24
Authority 25
Summary of Investigational Methods 26
General Description of Area 27

Definitions 31

Procedure for Evaluating Water Supply Systems 36

Results and Discussion

Classification of Supplies 45
State Program 46
General Description of Water Supply Systems 48
Facilities Appraisal 49
Bacteriological Evaluation 51
Chemical Evaluation 52
System Management 53
Operation and Surveillance 54
Consumer Acceptance 56
Waterborne Disease 57

Appendices

I - Pertinent Correspondence

II- Printout of Results

III-Forms Used to Gather Data

IV- Laboratory Survey Reports

V - Copies of Engineers Field Reports for Each Supply (in 14 Volumes)

VI- Methods and Procedures

VII-Details of Non-Standard Methods

2<

Vermont was requested

# FOREWORD

Early in 1969 Dr. Robert B. Aiken, Vermont State Health Commissioner, requested the United States Public Health Service to survey the public water supplies of his state. At that time, the Service had embarked upon a National Community Water Supply Survey under which one selected metropolitan area would be studied intensively in each PHS Region. Upon receipt of Dr. Aiken's request, the State of Vermont was substituted for another area of PHS Region I, and work on the survey was begun by mid-June.

Preliminary work completed, actual surveys of the 216 public water supplies began on July 7, 1969 and were completed by mid-September. Teams of 6-8 PHS engineers worked through the months of July and August making a personal visit to each supply. A detailed survey report was completed and water samples were collected for complete chemical and biological examination. Over 700 bacteriological and 3500 chemical samples were collected.

→ P4

The results justified Dr. Aiken's concern about the condition of public and individual water supplies in Vermont. Serious problems were discovered. The results of a period of inadequate surveillance by understaffed and overloaded environmental health personnel were all too evident. If the survey demonstrated nothing else, it showed clearly that health surveillance of public and individual water supplies is an absolute necessity. The survey, its findings, laboratory results, and recommendations are the subject of the report which follows.

The authors of this report wish to commend Dr. Aiken and his staff for the candor with which they approached this problem. They and each of the field engineers extend their appreciation to the large number of Vermonters who responded to the questions and assisted in so many ways and without whose wholehearted cooperation this work would not have been possible.

Floyd B. Taylor

Floyd B. Taylor
Regional Representative
Bureau of Water Hygiene
Director of Vermont Survey

Harry F. Smith Jr.

Harry F. Smith, Jr., P.E.
Regional Water Supply Consultant
Bureau of Water Hygiene
April 3, 1970

## Summary of Findings and Conclusions

Find data [illegible] in the report.

(1) 202 Community water supplies and 15 special water supplies were surveyed, sampled and rated in the study. Nine (9) Community supplies and one special supply serving a total population of 17,868 were rated Good; 61 Community supplies and 9 special supplies erving a total population of 188,226 were rated Fair; 66 Community supplies and 3 special supplies serving a total population of 40,820 were rated Poor; and 67 Community supplies and 2 special supplies serving a total population of 35,555 were rated Undesirable.

(2) Analysis of distribution system bacteriological samples taken during the survey indicated that 23% of the sample contained coliform bacteria in excess of Drinking Water Standards limits.

(3) Analysis of distribution system chemical samples taken during the survey indicated that the following number of supplies had one or more samples which exceeded the following standards: Lead 13 supplies, Iron 34 supplies, manganese 45 supplies.

(4) During the year preceding the survey, 64 supplies had no record of bacteriological analysis; 102 supplies did not meet PHS Drinking Water Standards bacteriological limits in one or more months, and the remaining 51 supplies did; on the basis of these ratios it can be projected that 32 of the 64 supplies which had no records were unsatisfactory, thus bring the total of unsatisfactory supplies to 134.

(5) The State Health Department's water supply surveillance program is inadequate; limited to taking care of emergency situations as they develop. Routine bacteriological monitoring is not practiced for most supplies, bad samples are not followed up in accordance with Drinking Water Standards requirements, recent chemical analysis results are not on hand and routine visits to water supplies are not made.

(6) Monitoring raw water quality is not practiced for most of the water supplies in Vermont.

(7) The prevailing attitude of the water consumer in Vermont is that his water supply is the best in the world and is too good to be chlorinated or treated in any way.

(8) Operation of water supply systems in Vermont is generally a part-time occupation; in fact some supplies are not under any operation control at all.

(9) Low water rates severely hamper supply "managers" in obtaining improvements and financing repairs. Small, privately owned systems are particularly hurt by low rates which are regulated by the Public Service Board.

(10) The State Health Department Laboratory in Burlington is certified to perform bacteriological analysis of water.

(11) Survey results showed that most systems generally are not in compliance with the following sections of the Drinking Water Standards.

a. Section 2.1 - protection of supply by treatment.

b. Section 2.2 - frequent sanitary surveys to locate and identify health hazards.

c. Section 2.3a - enforcement of rules and regulations to prevent development of health hazards.

d. Section 2.3b - frequent surveys of distribution systems.

e. Section 2.3c - proper operation of the water supply system under the responsible charge of personnel whose qualifications are acceptable.

f. Section 2.3d - adequate capacity to meet peak demands without development of low pressures.

g. Section 2.3e - record of laboratory examination.

h. Section 3.11 - representation sampling.

i. Section 3.12 - minimum number of samples to be collected.

j. Section 3.23 - resampling follow-up when bad samples are obtained.

(12) There have been over 300 cases of water borne disease reported during the last 3 years.

(13) Operators of most water supply systems are unable to determine water usage and do not plan for future demands.

## SUMMARY TABLE OF WATER SUPPLY EVALUATIONS

| Name | Population Served | Type of Supply * | Major Deficiencies | Overall Water Supply System Rating | Remarks |
|---|---|---|---|---|---|
| Tri-Town Water District #1 (Addison, Bridport, Shoreham) | 2000 | C | Poor surveillance | Good | 10 months without samples |
| Albany | 163 | C | No surveillance bad bacteriological quality | (Undesirable) Unfit to drink | Ave coliform density (6/100 ml exceeds mandatory standard |
| Alburg | 600 | C | Bad bacteriological quality | (Undesirable) Unfit to drink | Ave coliform density (4/100 ml) exceeds mandatory standard |
| Arlington | 1500 | C | Source improperly protected, poor surveillance | Poor | 8 months without samples |
| Ascutney | 75 | C | Source improperly protected, poor surveillance | Poor | 4 months without samples |
| Bakersfield | 350 | C | Bad bacteriological quality, Source improperly protected | (Undesirable) Unfit to drink | Ave coliform density (98/100 ml) exceeds mandatory standard<br>poor surveillance |
| Barnet (Dunbar) | 200 | C | Bad bacteriological quality, chemical quality, source prot. | (Undesirable) Unfit to drink | Ave. coliform density (34/100 ml) exceeds mandatory standard<br>Ave. nitrate (55mg/1) exceeds recommended standard |
| Barre | 10387 | C | No standby treatment units<br>Source improperly protected | Fair | |
| Barre-Berlin Central Vt. Hospital | 250 | S | Poor surveillance | Poor | 11 months without samples |

* C = Community
S = Special

| Name | Population Served | Type of Supply | Major Deficiencies | Overall Water Supply System Rating | Remarks |
|---|---|---|---|---|---|
| Barre-Deep Rock Water Co. | 50 | C | No surveillance | Poor | |
| Barre-Perry System | 120 | C | Bad bacteriological & chemical quality, no surveillance | (Undesirable) unfit to drink | Ave. coliform density (15/100ml) exceeds mandatory standard<br>Ave Iron (o.362mg/1) exceeds recommended standard |
| Barre-Quarry Hill | 100 | C | Bad bacteriological quality, poor surveillance | (Undesirable) unfit to drink | Ave coliform density (5.7/100ml) exceeds mandatory standard |
| Barton | 1100 | C | Source improperly protected, no standby chlorination | Poor | |
| Beebe | 200 | C | No surveillance, source improperly protected, bad bacteriological quality | (Undesirable) Unfit to drink | Ave coliform density (1.5/100ml) exceeds mandatory standard |
| Beecher Falls | 350 | C | poor surveillance | Poor | Taste & odor complaints, 8 months without samples |
| Bellows Falls | 4500 | C | Needs standby equipment | Fair | One sample contained fluoride of 1.8 mg/1 |
| Bennington | 9000 | C | Source improperly protected | Fair | Possible cross-connection with Soldiers Home spring |
| Berlin | 250 | C | Poor surveillance | Poor | Poor maintenance |
| Bethel | 600 | C | Poor bacteriological record | Poor | 3 months of bad samples |
| Big Bromley Ski Area | varies | S | No surveillance | | |
| Bloomfield | 50 | C | No surveillance, poor chemical quality | Fair | Ave. Iron (0.454 mg/1 and manganese (0.167 mg/1) exceeds recommended limits |
| Bolton Valley Ski Area | varies | S | Source improperly protected | Fair | No standby chlorination |

| Name | Population Served | Type of Supply | Major Deficiencies | Overall Water Supply System Rating | Remarks |
|---|---|---|---|---|---|
| Bradford | 810 | C | Source improperly protected, bad bacteriological record | Poor | Open distribution reservoir, no standby chlorination |
| Brandon | 2000 | C | Source improperly protected, bad bacteriological quality | (Undesirable)<br>Unfit to drink | No standby chlorination<br>Ave coliform density (2/100 ml) exceeds mandatory standard |
| Brattleboro | 11000 | C | NA | Good | Needs standby chlorination |
| Bridgewater | 25 | C | No surveillance, source improperly protected | Poor | |
| Bristol | 1900 | C | Bad bacteriological record | Poor | 5 months of bad samples |
| Burlington | 45000 | C | Poor chemical quality | Fair | Carbon Chloroform extract (.330 mg/1) exceeds recommended std. |
| 8<br>Cabot | 225 | C | Poor surveillance, bad bacteriological quality | Undesirable<br>Unfit to drink | Ave coliform density (1.7/100ml) exceeds mandatory std. |
| Cadys Falls | 100 | C | Poor surveillance, chemical quality, low pressures | Poor | Ave Iron (0.752 mg/1) exceeds recommended std. |
| Cambridge | 250 | C | Source improperly protected, bad bacteriological quality | Undesirable<br>Unfit to drink | Ave coliform density (3.0/100ml) exceeds mandatory std. |
| Canaan | 1000 | C | No surveillance, bad bacteriological quality | Undesirable<br>Unfit to drink | Ave coliform density (2.5/100ml) exceeds mandatory standards |
| Castleton | 900 | C | Wells subject to flooding, uncovered reservoir | Fair | |
| Cavendish | 600 | C | No surveillance, low pressures | Fair | |
| Chester | 1400 | C | Bad chemical quality, poor bacteriological quality | (Undesirable)<br>Unfit to drink | Ave. lead concentration (0.081mg/e exceeds mandatory std. Ave. coliform density (3.5/100ml) exceeds mandatory std. |

9
^

| Name | Population Served | Type of Supply | Major Deficiencies | Overall Water Supply System Rating | Remarks |
|---|---|---|---|---|---|
| Colchester F.D. #3 | 500 | C | Source improperly protected | Fair | |
| Colchester Hauke | 90 | C | Poor surveillance, intake improperly protected, poor chemical quality | Poor | Ave Iron (0.403mg/1 and Manganese (0.0[illegible]3mg/1) exceed recommended stds. |
| Colchester Mongeon | 100 | C | No surveillance, source improperly protected | Poor | Needs standby chlorination |
| Colchester Nourse | 150 | C | Bad bacteriological quality | Undesirable<br>Unfit to drink | Ave. coliform density (1.5/100ml) exceeds mandatory standard |
| Colchester Spaulding West Shore | 200 | C | No surveillance, source improperly protected, low pressures, bad bacteriological quality | Undesirable<br>Unfit to drink | Ave. coliform density (48/100ml) exceeds mandatory standard |
| Concord | 60 | C | Bad chemical quality, source improperly protected, poor surveillance | Undesirable<br>Unfit to drink | Ave lead concentration (0.205 mg/1 exceeds recommended std. |
| Coventry | 130 | C | Poor surveillance, source improperly protected, poor physical & chem. quality | Poor | Ave. color (35 units) and Iron (0.413mg/1) exceed recommended standards |
| Craftsbury | 35 | C | Poor surveillance, source improperly protected, bad bacteriological quality | Undesirable<br>Unfit to drink | Ave coliform density (5.0/100ml) exceeds mandatory std. |
| Craftsbury Common | 200 | C | Poor surveillance, source improperly protected | Poor | 10 months without samples |
| Cuttingsville | 62 | C | Poor surveillance, source improperly protected, low pressures | Poor | 8 months without samples |

| Name | Population Served | Type of Supply | Major Deficiencies | Overall Water Supply System Rating | Remarks |
|---|---|---|---|---|---|
| Danby | 1000 | C | Poor surveillance, bad bacteriological quality | Undesirable<br>Unfit to drink | Ave coliform density (2/100 ml) exceeds mandatory standard |
| Danville | 600 | C | Poor surveillance, poor chem. quality, Source improperly protected | Poor | Maximum manganese concentration (0.063 mg/l) exceeds recommended standard |
| Derby Ctr. | 400 | C | Poor surveillance, source improperly protected | Poor | 10 months without samples |
| Derby Line | 1500 | C | Source improperly protected, poor bacteriological record | Poor | 4 months of bad samples |
| Dorset | 800 | C | Bad bacteriological qual. | Undesirable<br>Unfit to drink | Ave. coliform density (1.5/100ml) exceeds mandatory std. |
| Duxbury | 350 | C | Bad bacteriological qual. poor surv., poor chem qual. | Undesirable<br>Unfit to drink | Ave. coliform density (10/100ml) exceeds mandatory std, ave copper concentration (1.833 mg/l) exceeds recommended std. |
| E. Barre | 580 | C | Poor surveillance | Fair | 10 months without samples |
| E. Barnet | - | C | Not in survey | | |
| E. Berkshire | 170 | C | Bad bacteriological qual.<br>Poor surveillance | Undesirable<br>Unfit to drink | Ave. coliform density (25.5/100ml) exceeds mandatory std. |
| E. Braintree | 35 | C | Bad bacteriological qual.<br>no surveillance | Unfit to drink<br>Undesirable | Ave. coliform density (8.5/100ml) exceeds mandatory std. |
| E. Burke | 125 | C | No surveillance, source improperly protected | Poor | |
| E. Calais | 150 | C | No surveillance, source improperly protected, low pressures | Poor | |
| E. Dorset | 120 | C | Poor chem. quality, poor bacteriological record | Poor | Ave. Iron concentration (0.417 mg/l) exceeds recommended std. |

| Name | Population Served | Type of Supply | Major Deficiencies | Overall Water Supply System Rating | Remarks |
|---|---|---|---|---|---|
| E. Hardwick | 200 | C | Bad bacteriological qual. no surveillance | Undesirable Unfit to drink | Ave. coliform density (18/100ml) exceeds mandatory stds. |
| E. Haven | 23 | C | No surveillance | Fair | |
| F. Haven Coffey-Teachout | 60 | C | No surveillance | Fair | |
| F. Highgate | 50 | C | No surveillance, poor chemical quality, low pressures | Poor | Ave. Iron concentration (3.932 mg/1) exceeds recommended std. |
| E. Middlebury | 1200 | C | Poor surveillance, source improperly protected, low pressures | Poor | 6 months without samples |
| E. Montpelier Deane Hedges | 300 | C | No surveillance, bad bacteriological quality | Undesirable Unfit to drink | Ave. coliform density (1.5 /100ml) exceeds mandatory std. |
| E. Ryegate | 160 | C | Source improperly protected, low pressures | Poor | |
| Elmore | 88 | C | No surveillance, source improperly protected | Poor | |
| Enosburg Falls | 750 | C | Poor surveillance, bad bacteriological quality, source improperly protected | Undesirable Unfit to drink | Ave. coliform density (315/100ml) exceeds mandatory std. |
| Essex Ctr. | 2500 | C | Source improperly protected, poor bacteriological record | Fair | 4 months of bad samples |
| Essex Jct. | 8000 | C | Bad bacteriological & chem. quality | Undesirable Unfit to drink | Ave. coliform density (3.8/100ml) and manganese concentration (01074 mg/1) exceed mandatory std. (coliform) & recommended std |

| Name | Population Served | Type of Supply | Major Deficiencies | Overall Water Supply System Rating | Remarks |
|---|---|---|---|---|---|
| Ethan Allen AFB | 1000 | C | Source improperly protected, poor chem. quality | Fair | Ave. manganese concentration (0.064 mg/1) exceeds recommended std. |
| Fairfax | 470 | C | Poor surveillance, poor chem quality Source improperly protected | Poor | Ave. Iron concentration (0.504mg/1 exceeds recommended std. |
| Fair Haven | 2400 | C | Source improperly protected, low pressures, cross connec. | Poor | Poor bacteriological record |
| Fairlee | 300 | C | Bad bacteriological quality, improperly protected | Undesirable<br>Unfit to drink | Ave. coliform density (12/100ml) exceeds mandatory std. |
| Florence | 130 | C | No surveillance | poor | |
| Florey System Ctr. Rutland | 50 | C | Poor surveillance, bad chem. quality, bad bacter. qual. | (Undesirable<br>Unfit to drink | Ave. lead concentration (0.075mg/1 exceeds mandatory std. Ave. coliform density (2.5/100ml) exceeds mandatory std. |
| Franklin | 250 | C | Poor surveillance, source improperly protected, low pressures | Poor | Maximum copper concentration (1.32 mg/1) exceeds recommended std. |
| Gilman | 400 | C | Fair surveillance, cross-connection | Fair | |
| Glover | 60 | C | Bad bacteriological quality no surveillance | Undesirable<br>Unfit to drink | Ave. coliform density (22/100ml) exceeds mandatory std. |
| Grand Isle | 120 | C | Intake improperly protected, low pressures | Fair | |
| Graniteville | 1350 | C | Source improperly protected | Fair | |
| Greensboro | 700 | C | Poor surveillance, source improperly protected, poor bacteriological record | Poor | 9 mos. without samples |

| Name | Population Served | Type of Supply | Major Deficiencies | Overall Water Supply System Rating | Remarks |
|---|---|---|---|---|---|
| Greensboro Bend | 64 | C | No surveillance, source improperly protected, low pressures | Poor | |
| Guildhall | 100 | C | Poor surveillance, source improperly protected | Poor | 9 months without samples |
| Hardwick | 1521 | C | Poor surveillance, source improperly protected | Poor | 6 months without samples |
| Hartford-Queeche | 300 | C | Poor surveillance, source improperly protected | Poor | 11 months without samples |
| Hinesburg | 500 | C | Source improperly protected taste & odor complaints | Fair | |
| Hinesburg-Lake Sunset Trailer Pk | 150 | S | Poor surveillance | Fair | 9 months without samples |
| Huntington Ctr. | 125 | C | Bad bacteriological qual. poor surveillance | Undesirable<br>Unfit to drink | Ave. coliform density (53 /100ml) exceeds mandatory std. |
| Hyde Park | 475 | C | Source improperly protected, low pressure | Fair | Ave copper concentration (1.404mg/ exceeds recommended std. |
| Island Pond | 1600 | C | Bad bacteriological quality source improperly protected | Undesirable<br>Unfit to drink | Ave. coliform density (34.5/100ml) exceeds mandatory std. |
| Irasburg | 200 | C | No surveillance, low press. bad bacteriological quality | Undesirable<br>Unfit to drink | Ave. coliform density (3.0/100ml) exceeds mandatory std. |
| Jeffersonville | 500 | C | Source improperly protected low pressures | Poor | |
| Jeffersonville-Madonna Mt. Ski Area | varies | S | No surveillance, source improperly protected, poor chem. quality | Poor | Ave. Iron concentration (0.463 mg/ and manganese (0.05 mg/l) exceeds recommended stds |

13<

| Name | Population Served | Type of Supply | Major Deficiencies | Overall Water Supply System Rating | Remarks |
|---|---|---|---|---|---|
| Jericho | 700 | C | Poor surveillance, source improperly protected | Fair | 4 months without samples |
| Johnson | 1000 | C | Source improperly protected, poor chemical quality | Fair | Ave. iron concentration (0.453 mg/1) exceeds recommended std. |
| Jonesville | 125 | C | No surveillance source improperly protected; poor chemical quality | Poor | Ave. Iron concentration (0.450mg/1) exceeds recommended std. |
| Killington Ski Area | varies | S | | | |
| Ludlow | 2000 | C | Poor chemical quality, poor surveillance | Fair | Ave. Iron concentration (0.683mg/1) exceeds recommended standard |
| Lunenburg | 90 | C | Bad bacteriological quality, source improperly protected<br>Poor surveillance | Undesirable<br>Unfit to drink | Ave. coliform density (11.5/100ml) exceeds mandatory standard |
| Lyndonville | 3000 | C | Bad bacteriological quality, source improperly protected | Undesirable<br>Unfit to drink | Ave. coliform density (1.0.3/100ml) exceeds mandatory standard. |
| Manchester | 2500 | C | Poor surveillance. Bad bacteriological quality, source improperly protected | Undesirable<br>Unfit to drink | Ave. coliform density (1.5/100ml) exceeds mandatory standard |
| Marshfield | 375 | C | Poor surveillance | Fair | |
| Maxham-Worcester | 180 | C | No surveillance, poor chemical quality | Poor | Ave. manganese concentration (0.79 mg/1) exceeds recommended standard |
| Mendon- E. Ridge | 78 | C | Poor surveillance | Good | 9 months without samples |
| Mendon Water Society | 26 | C | Bad bacteriological quality no surveillance, source prot. | Undesirable<br>Unfit to drink | Ave. coliform density (20/100ml) exceeds mandatory standard |

| Name | Population Served | Type of Supply | Major Deficiencies | Overall Water Supply System Rating | Remarks |
|---|---|---|---|---|---|
| Middlebury | 5500 | C | Source improperly protected. Poor chemical quality | Fair | Ave manganese concentration (0.179mg/1) exceeds recommended standard |
| Middlesex-non-profit | 25 | C | Poor surveillance, source improperly protected; cross connection | Poor | 11 months without samples |
| Middlesex-Church St. | 25 | C | No surveillance, source improperly protected, low pressure bad bact. qual. | Undesirable<br>nfit to drink | Ave. coliform density (2/100ml) exceeds mandatory standard |
| Middlesex-Westover | 25 | C | No surveillance, bad chemical quality | Unfit to drink<br>Undesirable | Ave lead concentration (0.114mg/1) exceeds mandatory standard |
| Milton | 2000 | C | Bad bacteriological record. Improper chlorination | Poor | 10 months of bad samples |
| 15 Milton-Birchwood Manor Trailer Pk. | 450 | S | No surveillance | Fair | 12 months without any samples |
| Milton Checkerberry Pk Trailer Pk | 200 | S | Poor chem. qual. | Fair | Ave. manganese concentration (0.078mg/1) exceeds recommended standard |
| Milton Dana Corp. | 200 | C | Poor surveillance, bad bact. quality | Undesirable<br>Unfit to drink | Ave. coliform density(2/100ml) exceeds mandatory standard |
| Montgomery St. Onge W.S. | 70 | C | Bad bact. qual. No surv. source improperly protected | Undesirable<br>Unfit to drink | Ave. coliform density (16.5/100ml) exceeds mandatory standard |
| Montgomery Ct. | 90 | C | Poor surveillance, low pressures | Poor | 9 months without any samples |
| Montpelier | 9500 | C | Source improperly protected, low pressures, poor | Fair | Ave. manganese concentration (0.126mg/1 exceeds recommended standard |

| Name | Population Served | Type of Supply | Major Deficiencies | Overall Water Supply System Rating | Remarks |
|---|---|---|---|---|---|
| Montpelier-Towne Hill | 150 | C | No surveillance | Poor | |
| Morristown Corners | 125 | C | Bad bacteriological quality,poor surv. | Undesirable Unfit to drink | Ave. coliform density (6/100ml) exceeds mandatory standard |
| Morrisville | 2500 | C | Low pressures,poor bact. record | Fair | 3 months exceed bacteriological stds. |
| Newbury | 375 | C | Bac bact. record, poor chem. quality | Poor | Ave. Iron concentration (0.724mg/l) exceeds recommended std. 10 mos of high contamination |
| Newport | 5019 | C | Inadequate sampling, open reservoir.Inadequate monitoring | Fair | |
| Newport Ctr. | 240 | C | Poor surveillance,source improperly protected, poor chem. quality | Fair | 5 mos. without any samples.Ave. manganese concentration(0.498 mg/l) exceeds recommended stds. |
| No. Bennington | 3300 | C | Poor surveillance | Fair | 9 mos. without any samples |
| No. Hartland | 250 | C | Poor surv; poor chem. quality | Poor | Ave. iron concentration (1.609mg/l) and manganese concentration (0.099mg/ exceeds recommended stds.10 mos. without any samples |
| N. Hyde Park | 100 | C | No surv.poor chem. qual. | Poor | 12 mos. without any samples.Ave. manganese concentration(0.598mg/l) exceeds recommended stds. |
| N. Montpelier | 75 | C | No surveillance, source improperly protected | Poor | 12 mos. without any samples |
| No. Pownal | 100 | C | No surv. poor them. qual. source improperly protected. | Poor | Ave. manganese concentration (0.099mg/ exceeds recommended std. 2 mos withou samples. |

| Name | Population Served | Type of Supply | Major Deficiencies | Overall Water Supply System Rating | Remarks |
|---|---|---|---|---|---|
| No. Thetford Village | 25 | C | No surv. source improperly protected | Poor | |
| No. Thetford Union | 100 | C | No surv, source improperly protected, bad chem. quality | Poor | Ave. lead concentration ( ) exceeds mandatory standard |
| No. Troy | 975 | C | Bad bact. quality, poor surveillance | Undesirable Unfit to drink | Ave. coliform concentration (200/100ml) exceeds mandatory standard |
| N. Westminster Aqueduct Co. | 35 | C | Bad chem. qual., poor bact. qual. No surv. | Undesirable Unfit to drink | Ave. lead concentration (0.286mg/l) exceeds mandatory standard |
| No. Westminster Water Co-op. | 100 | C | Bad chem. quality | Undesirable Unfit to drink | Ave. leadconcentration (0.056mg/l) exceeds mandatory standard |
| Northfield | 4500 | C | Improper monitoring, source improperly protected | Fair | Samples not taken from distribution point |
| Norwich | 800 | C | Poor chemical quality | Poor | Ave manganese concentration (0.267mg/l) exceeds recommended standard |
| Orleans | 1800 | C | Source improperly protected | Fair | |
| Passumpsic | 125 | C | Bad bacteriological quality, no surveillance, source improperly protected | Undesirable Unfit to drink | Ave. coliform density (29/100ml) exceeds mandatory standard |
| Peacham | 100 | C | Bad bacteriological quality, poor surveillance | Undesirable Unfit to drink | Ave. coliform density (1347/100ml) exceeds mandatory standard |
| Pinewood Manor | 500 | C | Poor physical chemical qual. Treatment By-pass | Poor | Ave. Iron concentration(0.661 mg/l) and manganese concentration (0.068mg/l) & turbidity (5.5Tu exceed recommended standards |
| Pittsfield Mt. Wilcox VA. | 100 | C | Poor surveillance, source improperly protected, poor bacteriological record | Poor | Ave. copper concentration (0.138) exceeds recommended standard |

17<

| Name | Population Served | Type of Supply | Major Deficiencies | Overall Water Supply System Rating | Remarks |
|---|---|---|---|---|---|
| Pittsford | 1400 | C | Source improperly protected, poor bact. record | Poor | 5 months of bad samples |
| Plainfield | 840 | C | Poor surveillance, source improperly protected | Poor | 9 mos. without samples<br>2 mos. of bad samples |
| Poultney | 1750 | C | Source improperly protected,poor bact. record | Poor | 6 mos. of bad samples |
| Pownal | 600 | C | Bad bact. qual, no surv. | Undesirable<br>Unfit to drink | Ave. coliform density (11/100ml) exceeds mandatory std. |
| Pownal Ct. Campman | 15 | C | Not to be included | | |
| Proctor | 2200 | C | No standby chlorination, no residual in system | Fair | |
| Proctorsville | 450 | C | Poor surveillance,poor chemical quality | Fair | Ave. manganese concentration (0.890mg/1) exceeds recommended std. 5 mos. without samples |
| Putnamville | 60 | C | Poor surveillance | Fair | 6 mos. without any samples |
| Putney-Windham College | 900 | S | No surveillance,poor chem. quality | Fair | Ave. copper concentration (2.668 mg/1) exceeds recommended std. |
| Randolph | 2200 | C | Source improperly protected, no standby chlorination | Fair | |
| Randolph Ctr. | 140 | C | Poor surv. low pressures | Poor | 11 mos. without any samples |
| Randolph Ctr. Vt. Tech. Col. | 650 | S | Poor surveillance | Poor | 11 mos. without any samples |
| Readsboro | 500 | C | Bad bact. qual, poor physical qual., poor surv., bact. rec. | Undesirable<br>Unfit to drink | Ave. coliform density (4/100ml) exceeds mandatory std. Ave. color (35 units) exceeds rec. std.<br>4 mos. of very bad samples |

| Name | Population Served | Type of Supply | Major Deficiencies | Overall Water Supply System Rating | Remarks |
|---|---|---|---|---|---|
| Red Mountain WC Arlington | 45 | C | Bad bact. qual. no surv. poor maintenance | Undesirable Unfit to drink | Ave. coliform density (22/100ml) exceeds mandatory std. |
| Richford | 1800 | C | Poor bact. rec. poor maintenance | Fair | 3 months of bad samples |
| Richmond | 800 | C | Poor bact. record; low pressures | Fair | 3 mos. of bad samples |
| Rochester | 450 | C | Bad bact. qual; poor surv.; poor maintenance | Undesirable Unfit to drink | Ave. coliform density (5/100ml) exceeds mandatory std. 11 mos without any samples |
| Rockingham Belmont Mobile Ct. | 100 | S | Bad bact. quality; poor chem. qual.; poor surv. | Undesirable Unfit to drink | Ave. coliform density (6.5/100ml) exceeds mandatory std. Ave. manganes concentration (0.698mg/1) exceeds recommended std. |
| Rutland | 19500 | C | Source improperly protected.$Cl_2$ inoperable | Fair | |
| Rutland-Pico Villa | 40 | C | No surveillance | Good | Small development supply |
| Rutland Town Fire Dist #1 Ctr. Rutland | 260 | C | Bad bact. quality; source improperly protected;poor surv. | Undesirable Unfit to drink | Ave. coliform density (35.5/100ml) exceeds recommended std. 11 mos. without any samples |
| **St. Albans** | 9000 | C | Poor chem. quality; low pressures | Fair | Ave. Iron concentration (0.397mg/1) and manganese concentration (0.423mg/ exceed recommended stds. |
| **St. George Villas** | **200** | C | Bad bact. & chem.qual. no surveillance | Undesirable Unfit to drink | Ave. coliform density (1.5/100ml) & manganese concentration (1.61mg/1) exceeds mandatory std. (coliform & recommended std. |

19<

| Name | Population Served | Type of Supply | Major Deficiencies | Overall Water Supply System Rating | Remarks |
|---|---|---|---|---|---|
| St. Johnsbury | 7000 | C | Poor surv. source improperly protected; low pressures | Poor | |
| St. Johnsbury Ctr. | 400 | C | Source improperly protected | Fair | |
| Saxtons River Barnes | 120 | C | Bad bact. quality;no surv. | Undesirable<br>Unfit to drink | Ave. coliform density (6.5/100ml) exceeds mandatory std. |
| Saxtons River Clark | 40 | C | No surveillance | Fair | |
| Sharon-Green Trailer Pk | 22 | S | No surv. poor chem. quality | Fair | Ave. manganese concentration (0.063mg/1) exceeds recommended std. |
| Shelburne | 3200 | C | | Good | |
| Shelburne Harbor | 40 | C | No surveillance,low pressures | Poor | No samples for 12 months |
| Sheldon | 100 | C | Low pressures, poor maintenance | Fair | |
| Sheldon Springs | 300 | C | No standby chlorination; low fluoride concentration | Fair | |
| S. Burlington Queen City | 300 | C | No operator<br>Poor surveillance | Fair | No samples for 4 months |
| S. Hero FD#1 | 180 | C | Bad Bact. qual. | Undesirable<br>Unfit to drink | Ave. coliform density (3.7/100ml) exceeds mandatory std. |
| S. Hero FD #2 | 100 | C | Low pressure, intake improperly protected | Fair | |
| S. Hero-Keeler's Bay | 80 | C | Poor chemical quality intake improperly protected | Fair | |

| Name | Population Served | Type of Supply | Major Deficiencies | Overall Water Supply System Rating | Remarks |
|---|---|---|---|---|---|
| S. Royalton-Eaton | 75 | C | No surveillance, bad bact. quality, poor maintenance | Undesirable<br>Unfit to drink | Ave. coliform density (1.5/100ml) exceeds mandatory std. |
| S. Royalton Village | 637 | C | Bad chem. qual., poor bact. record, poor surv. | Undesirable<br>Unfit to drink | Ave. lead concentration (0.137mg/1) exceeds mandatory std. 5 mos of bad samples, 7 mos without any samples |
| S. Ryegate | 30 | C | No surv., low press. | Fair | |
| S. Troy | 350 | C | Bad. bact. qual.;poor surveillance | Undesirable;<br>Unfit to drink | Ave. coliform density (207.5/100ml) exceeds mandatory std. 8 mos without samples |
| S. Wallingford | 75 | C | Poor surveillance | Fair | 8 mos without any samples |
| Springfield | 8000 | C | Low pressures, no standby chlorination | Fair | |
| Starksboro | 200 | C | Inadequate surveillance | Fair | |
| Stowe-Lower | 200 | C | No surveillance, low pressures | Poor | |
| Stowe Village | 800 | C | | Good | |
| Stratton Mtn. | varies | S | Bad bact. qual.,poor surveillance | Undesirable<br>Unfit to drink | Ave. coliform density (5/100ml) exceeds mandatory std. |
| Sugarbush Ski Area | varies | S | Poor surveillance | Fair | 11 mos. without samples |
| Sutton | 64 | C | Bact. qual; poor Surv., low pressures | | Ave. coliform density 3/100ml exceeds recommended std. Ave. nitrate con-Centration (98mg/1) exceeds recommended std. |
| Swanton | 2500 | C | Poor bact. record, source improperly protected | Poor | 6 mos. of bad samples |
| Thetford Hill | 120 | C | Bac bact. & chem. qual., No surveillance | Undesirable<br>Unfit to drink | Ave. coliform density 3/100ml) and & manganese concentration (0.189mg/1) exceed mandatory std. (coliform & rec.s. |

| Name | Population Served | Type of Supply | Major Deficiencies | Overall Water Supply System Rating | Remarks |
|---|---|---|---|---|---|
| Underhill | 475 | C | Bad bact. quality,no surveillance | Undesirable<br>Unfit to drink | Ave. coliform density (1.5/100ml) exceeds mandatory standard |
| Vergennes | 2000 | C | Poor chem. qual. No standby chlorination | Fair | Ave. manganese concentration (0.133mg/1) exceeds recommended std. |
| Wallingford | 800 | C | Poor surv., poor maintenance | Fair | 8 mos. without any samples |
| Washington | 800 | C | Poor surv., low pressures poor maintenance | Poor | 6 mos. without any samples |
| Waterbury | 4500 | C | Inadequate surv., no standby chlorination | Fair | 3 mos. without any samples |
| Waterbury Ctr. | 500 | C | No surv., source inadequate-protected | Poor | |
| Waterbury Wards Trailer Pk. | 50 | S | No surv. | Fair | |
| Waterville | 100 | C | No surv., source improperly protected;poor chem. quality | Poor | Ave. copper concentration (1.685mg/1) exceeds recommended std. |
| Websterville | 460 | C | Poor surv., source improperly protected | Fair | 5 mos. without any samples |
| Websterville-Wells Lamson | 65 | C | Poor surv., source improperly protected; low pressures | Poor | 11 mos. without any samples |
| Wells River | 450 | C | Poor chem. qual.; poor bact. record | Fair | Ave. manganese concentration (0.538mg/1) exceeds recommended std., 5 mos. of bad samples |
| W. Burke Fairbrother | 75 | C | Bad. Bact. quality,poor surv. | Undesirable<br>unfit to drink | Ave. coliform density (18.5/100ml) exceeds mandatory std. |

| Name | Population Served | Type of Supply | Major Deficiencies | Overall Water Supply System Rating | Remarks |
|---|---|---|---|---|---|
| W. Burke Water Co. | 40 | C | Bad bact. quality, poor surv., low pressures | Undesirable; unfit to drink | Ave. coliform density (80/100ml) exceeds mandatory standard |
| W. Burke Wagner | 75 | C | Bad bact. qual, no surveillance | Undesirable; unfit to drink | Ave. coliform density (7/100ml) exceeds mandatory standard |
| Westfield | 100 | C | Bad bact. quality, poor surveillance | Undesirable<br>Unfit to drink | Ave. coliform density (7/100ml) exceeds mandatory standard |
| Westminster | 700 | C | No surveillance, low pressures | Poor | |
| W. Rutland | 1950 | C | Bad chemical quality, low pressures; poor maintenance | Undesirable<br>Unfit to drink | Ave. lead concentration (0.170mg/l) exceeds mandatory standard |
| Wheelock | 60 | C | No surveillance, source improperly protected | Poor | |
| White River Jct. | 4700 | C | Poor chemical quality | Fair | Ave. manganese concentration (0.341mgl/) exceeds recommended standard |
| Williamstown-Gilbert & Upper Robinson | 410 | C | Source improperly protected; poor bact. rec. | Fair | 3 mos. of bad samples |
| Williamstown Lower Robinson | 250 | C | Source improperly protected; poor bact. rec. | Fair | 6 mos. of bad samples |
| Lamplighter Acres | 400 | C | Poor surveillance | Good | 7 mos. without samples |
| Williston-Meadowbrook | 200 | C | Inadequate surveillance | Good | 4 mos. without samples |
| Williston-Oakhill | 200 | S | Poor chemical quality | Fair | Ave. manganese concentration (0.317mg/l) exceeds recommended standard |

| Name | Population Served | Type of Supply | Major Deficiencies | Overall Water Supply System Rating | Remarks |
|---|---|---|---|---|---|
| Williston-Onedia | 135 | C | Source improperly protected; poor surv. | Fair | 8 mos. without samples |
| Williston-Williston Hills | 150 | C | NA | Good | |
| Wilmington | 650 | C | Bad bact. quality; no surv. | Undesirable<br>Unfit to drink | Ave. coliform density (65/100ml) exceeds mandatory std. |
| Windsor | 3500 | C | Poor bact. record | Fair | 3 mos of bad samples |
| Winooski | 7500 | C | Low pressures | Fair | |
| Woodstock | 1515 | C | Inadequate surv. | Fair | 4 mos. without samples |

## Recommendations

It is recommended that:

(1) The State Department of Health Water Supply Surveillance Program be greatly improved. This improvement should include:

a. Hiring at least one Professional Sanitary Engineer to devote full time to the development and implementation of a water supply surveillance and assistance program. He should be assisted by one junior engineer and three sanitarians. This program should cover:

1. Development of a bacteriological monitoring program for all community water supplies in accordance with the PHS Drinking Standards requirements.

2. A program for annual analysis for all chemical and physical constituents covered in the Public Health Service Drinking Water Standards.

3. Initiation of procedures for telephone notification and follow-up on all samples exceeding PHS Bacteriological standards.

4. Development of a program of surveying every water supply on a yearly basis. This program will require setting priorities for the order in which supplies will be visited initially. Priority should be based on bacteriological record, (i.e., surveying supplies with known bacteriological problems first); operation problems; requests for assistance; results from CWSS reports. (Bacteriological and lead problems in particular).

5. Development of close cooperation with the Division of Water Supply and Pollution Control of the Department of Water Resources.

6. Initiation of a program of providing positive recommendations for improving existing water supply facilities and new facilities through obtaining adequate treatment, plan review, consultation and inspection. The Volumes in Appendix V can form the basis for the development of a systematic program of corrective action.

(2) Substandard water supply systems in Vermont be improved through assistance in obtaining adequate treatment guidance in record keeping, operation and development of monitoring and surveillance programs.

(3) A program for water supply system operator or person in-charge training be developed and carried on throughout the state. This program should include:

a. Monitoring

b. Treatment operation.

c. Maintenance

d. Distribution surveillance

(4) The State Department of Health stimulate planning for future development through metering, coordination of resource development, combining of water supply facilities, and determining safe yields of supplies.

(5) A public education program stressing water resource protection and water supply needs be developed and actively promoted.

(6) A program of elimination of health hazards should be developed which will reach all public water supplies under the aegis of the State Department of Health.

(7) Legislation clearly defining the role of the State Health Department in Water Supply and providing sound legal basis and authority for action be developed.

# Introduction

## Purpose and Background

In February of 1969, the Bureau of Water Hygiene of the U.S. Public Health Service, in cooperation with state and local health departments, and the water utilities, initiated a nationwide Community Water Supply Study (CWSS). The purpose of this study was, one, to determine whether or not the quality of the American consumer's drinking water of the country met the 1962 U. S. Public Health Service Drinking Water Standards, and two, to determine the nature and reliability of these water supply systems.

The study was designed to give an assessment of drinking water quality in urban areas in each of the regions of the Department of Health, Education and Welfare. Study areas were selected to give examples of the several types of water supplies in the country. The whole metropolitan area (SMSA) was the basis of the study, with assessments made on all public water supplies, as defined herein, in each study area. This coverage allowed an assessment of the drinking water quality of the large central city, the suburbs, and the smaller communities located in the counties in the SMSA, and the interaction between them.

The areas studied in each DHEW Region were:

Region I - State of Vermont

Region II - New York, New York

Region III - Charleston, West Virginia

Region IV - Charleston, South Carolina

Region V - Cincinnati, Ohio - Kentucky - Indiana

Region VI - Kansas City, Missouri - Kansas

Region VII - New Orleans, Louisians

Region VIII - Pueblo, Colorado

Region IX - San Bernadino - Riverside, Ontario, California

## Authority

The authority for the Community Water Supply Study is found in Title III, Part A, Section 301, Public Health Service Act, as amended (42 U.S.C. 241).

> "Sec. 301 - The Surgeon General shall conduct in the Service, and encourage, cooperate with, and render assistance to other appropriate public authorities, scientific institutions, and scientists in the conduct of, and promote the coordination of, research, investigations, experiments, demonstrations, and studies relating to the causes, diagnosis, treatment, control, and prevention of physical and mental diseases and impairments of man, including water purification . . . "

## Summary of Investigational Methods

In the State of Vermont 217 public water supplies, including 202 community water supplies and 15 special water supplies (as defined below) were studied. Each water supply was investigated on two bases:

(1) water quality delivered to the consumer, and (2) the nature and adequacy of the water supply system itself. The drinking water quality was determined by sampling the finished and distributed water and returning these samples to the laboratories of the Bureau of Water Hygiene for bacteriological, chemical and trace metal analyses. The nature and adequacy of the water supply system was determined by evaluating five items, where applicable: (1) source(s), (2) treatment, (3) distribution system, (4) operation and operators, and (5) surveillance program. This evaluation was accomplished by a field inspection of the supply and gathering of data on three standard forms (see Appendix B). In addition, water quality data for the previous year was obtained from state and county health department records. When these investigations were complete, each water supply was rated either as: excellent, good, fair, poor, or undesirable, according to the method outlined in the Section: Procedure for Evaluating Water Supply Systems.

## General Description of Area

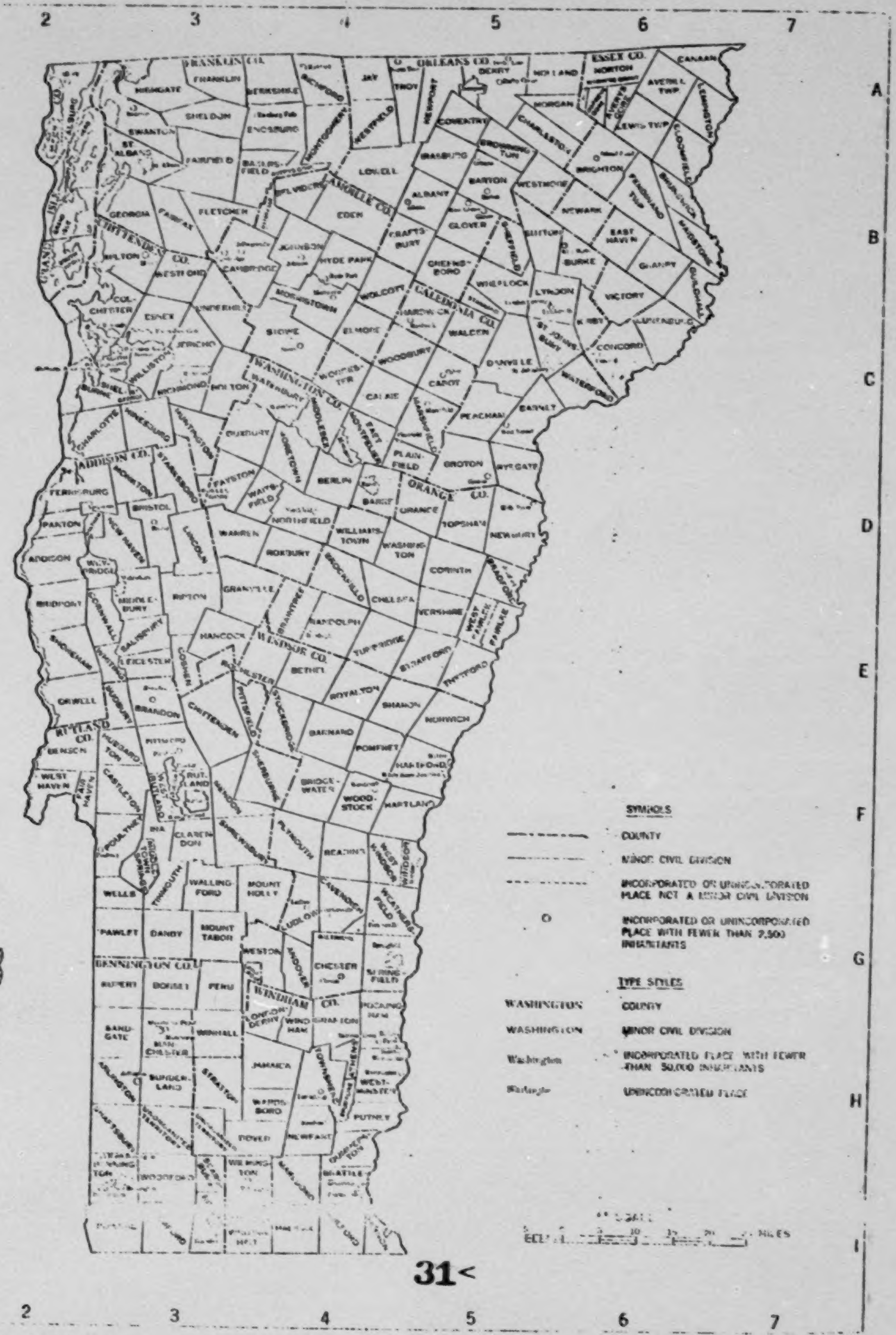
The "Free and Independent Republic of Vermont" was founded July 8, 1777 by representatives of the New Hampshire Grants who met at the Old Constitution House in Windsor, Vermont. During this period its leading soldier-statesman, General Ethan Allen, was making U. S. history by his heroic capture of Fort Ticonderoga "In the Name of the Great Jehovah and the Continental Congress". Since its founding, Vermont has contributed to the nation two Presidents, Chester A. Arthur and Calvin Coolidge, and many famous statesmen such as U.S. Senators Daniel Webster and Justin Smith Morrill. But, perhaps of most significance, Vermont has been and continues to be the home of a sturdy stock of honest folk who have farmed its stubborn hills, quarried and shaped its granite and marble and created a never-to-be-forgotten vacation land out of a natural beauty spot. As one of the PHS survey engineers put it, "Vermont is just one big national park." Vermont is so geographically situated and provided with modern highway and air systems as to be accessible to vacationers from all over the northeast and for that matter, the world via Burlington International Airport. Baroness Maria Von Trapp selected the spectacular Stowe area as her adopted American home because the Green Mountains there reminded her so much of her native Salzburg, Austria.

Undoubtedly "tourism" is Vermont's chief "industry". This it has promoted by formation of 33 state forests, 35 state parks, and 61 public recreation areas. There are an additional 52 privately owned campgrounds and 112 commercial summer camps for boys, girls, and adults. Recent figures show annual recreation output as 575,000 skier days; 500,000 camper days; and 550,000 swimming and picnicking visits. Because tourism is so prevalent, it is doubly important that the quality of Vermont's water supplies be above reproach as disease contracted there could be transported almost anywhere. The dominant geologic formation is the Green Mountain Range which runs the length of the State from the Massachusetts State Line to the Canadian Border. While not as high as the White Mountains of New Hampshire, there are several peaks over 4,000 feet. The winding road systems which criss-cross the state follow the north-south mountain valleys and east-west passes through the mountains.

The State's chief hydrologic feature is Lake Champlain, discovered in 1609 by Samuel deChamplain. Having an overall shoreline greater than 200 miles, it forms 2/3 of the western border of the State which is bounded entirely on the east by the Connecticut River. Lake Champlain is the source of drinking water for seven (7) municipalities. Additional

FIGURE 1.

VERMONT – MINOR CIVIL DIVISIONS–CITIES, TOWNS, ETC.


FRANKLIN CO.
ORLEANS CO.
ESSEX CO.
LAMOILLE CO.
CHITTENDEN CO.
CALEDONIA CO.
WASHINGTON CO.
ADDISON CO.
ORANGE CO.
WINDSOR CO.
RUTLAND CO.
BENNINGTON CO.
WINDHAM CO.
GRAND ISLE CO.
CANADA
NEW YORK
NEW HAMPSHIRE
MASSACHUSETTS
SYMBOLS
COUNTY
MINOR CIVIL DIVISION
INCORPORATED OR UNINCORPORATED PLACE NOT A MINOR CIVIL DIVISION
INCORPORATED OR UNINCORPORATED PLACE WITH FEWER THAN 2,500 INHABITANTS
TYPE STYLES
WASHINGTON
COUNTY
WASHINGTON
MINOR CIVIL DIVISION
Washington
INCORPORATED PLACE WITH FEWER THAN 50,000 INHABITANTS
Washington
UNINCORPORATED PLACE
SCALE
MILES
A
B
C
D
E
F
G
H
I
2
3
4
5
6
7

Larger scale copies of this map may be purchased from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., after April 1, 1961.

water resources of Vermont include 2,083 miles of rivers and streams (a), 235,000 acres of lakes and ponds (b), and thousands of springs. The ponds and springs are the principal sources of most of the state's public water supplies. Replenishment of the water resources is furnished by an annual average precipitation of 41 (c) inches of which an average 23 (c) inches runs into streams and lakes at an estimated 10 b.g.d. (c)

The 1960 Census showed Vermont's population to be 389,800 of which 38.5% was classified as urban. Past and projected population for other years are as follows: (1)

| Year | 1950 | 1960 | 1970 | 1980 | 1990 | 2000 | 2010 |
|---|---|---|---|---|---|---|---|
| Total Population | 377,700 | 389,800 | 410,000 | 421,000 | 440,000 | 456,000 | 475,000 |
| % Urban | 36.4 | 38.5 | 39.2 | 40.9 | 42.3 | 44.0 | 45.8 |

These figures do not reflect the winter and summer seasonal influx of an estimated 200,000 persons per year.

As stated above, tourism is one if not the most important single industry. The following table summarizes the frequency distribution of employment: (2)

| | |
|---|---|
| Total Work Force | 177,750 |
| Employed | 170,750 |
| Farm and Self-Employed | 31.500 |
| Manufacturing | 43,450 |
| Non-manufacturing | 95,800 |

However, the per capita average income (1967) was only $2,775, the second lowest in New England. The basic political power structure unit is the town of which there are 246 organized in the 14 Vermont counties as shown by the map of Figure 1. The town is governed by a board of Selectmen

(a) Drainage area over 10 square miles.
(b) Of size over 20 acres.
(c) USGS Water supply paper No. 1800.

(1) Straight line projection
(2) Vt. Development Department (1969)

who correspond to Township Commissioners in other states but who have much greater authority. Frequently one or more of the Selectmen serve also as water commissioners or Trustees. As the Selectmen are often otherwise regularly employed, this leads to a certain lack of basic responsibility for operating the town water supply. This will be discussed elsewhere.

A description of the study area would be incomplete without some mention of the distribution of land use. According to the Vermont Central Planning Office (1962) this was as follows:

| | Acres | % of State Area |
|---|---|---|
| Forests | 4,085,560 | 66.3 |
| Open farm land | 1,468,542 | 23.8 |
| Water and marshes | 322,297 | 5.2 |
| Highways | 127,768 | 2.1 |
| Vacant mountains and rock | 67,402 | 1.1 |
| Urban | 48,038 | 0.8 |
| All other | 43,531 | 0.7 |
| Total | 6,163,138 | 100.0 |

## Definitions

Back Flow -- The flow of water or other liquids, mixtures, or substances into the distributing pipes of a potable supply of water from any source or sources other than its intended source. Back siphonage is one type of backflow.

Back Flow Connection -- Any arrangement whereby backflow can occur.

Back Siphonage -- The flowing back of used, contaminated, or polluted water from a plumbing fixture or vessel or other sources into a water supply pipe due to a negative pressure in such pipe.

Bad sample -- A bacteriological sample that showed the presence of coliform bacterial contamination.

Consumer -- One person using the water for domestic and culinary purposes.

Cross Connection -- Any physical connection or arrangement between two otherwise separate piping systems, one of which contains potable water and the other either water of unknown or questionable safety, or steam, gas, or chemical, whereby there may be a flow from one system to the other, the direction of flow depending on the pressure differential between the two systems. See Backflow and Back siphonage.

Fecal Coliform Bacteria -- That portion of the total coliform population which are capable of lactose fermentation at an elevated temperature of 44.5°C. Unlike some strains of the non-fecal members of the total coliform group, fecal coliforms have a specific high order of positive correlation with warm-blooded animal pollution, survive for a shorter time in water and soil, and more closely correlate with survival patterns of enteric pathogenic bacteria.

Good Sample -- A bacteriological sample that did not show the presence of coliform bacterial contamination.

Inter-Connection -- A connection between the water supply and one or more additional sources of water not under the jurisdiction or control of the water supply operator.

**Mandatory Limit** -- The upper limit of density of coliform bacteria as described in Section 3.23, as modified below, of the concentration of certain ions as described in Section 5.22 and 5.23 and of radioactivity as described in Section 6.22, Public Health Service Drinking Water Standards, 1962 (PHS Publication No. 956). For these samples collected for this study, the bacterial limit was exceeded if the arithmetic average was more than 1 coliform per 100 ml. Also, for this study the total chromium concentration was considered to be hexavalent chromium.

Persons Served -- The aggregate number of consumers.

Plate Count -- A measure of the general bacterial population present in the water sample as described in Standard Methods for the Examination of Water and Wastewater, 12th Ed. These bacteria will produce colonies on plate count agar in 48 hours when incubated at 35°C (95°F).

Recommended Limit -- The upper limit of concentration of turbidity, color, chemicals and radioactivity as described in Sections 4.2; 5.21; and 6.21, PHS Drinking Water Standards, 1962 (PHS Publication No. 956).

Responsible Operator -- The operator at the treatment plant responsible for the day to day operation of the treatment facilities. Where there is no treatment, the person responsible for the operation of the system.
He is not necessarily the water superintendent.

Service Connection -- A physical connection to a water main for the purpose of conveying water to a building or onto a premise for use.

Standard Metropolitan Statistical Area -- The boundaries and titles of standard metropolitan statistical areas are established by the Bureau of the Budget with the advice of the Federal Committee on Standard Metropolitan Statistical Areas. This Committee is composed of representatives of the major statistical agencies of the Federal Government. In applying the following criteria, data from the following sources are used by the Committee:

> Population, labor force, density, and occupational data: Bureau of the Census and Bureau of Employment Security.

Employment by place of work: Bureau of Old-Age and Survivors Insurance, Department of Labor, Department of Defense, and Civil Service Commission.

Volume of commuting: Bureau of the Census and Bureau of Employment Security.

An SMSA is a county or group of contiguous counties which contains at least one city of 50,000 inhabitants or more or "twin cities" with a combined population of at least 50,000. In addition to the county, or counties, containing such a city or cities, contiguous counties are included in an SMSA if, according to certain criteria, they are essentially metropolitan in character and are socially and economically integrated with the central city. The criteria followed in the delineation of SMSA's relate to a city, or cities, of sufficient population size to constitute the central city and to the economic and social relationships with contiguous counties that are metropolitan in character.

1. Each SMSA must include at least:
a. One city with 50,000 inhabitants or more, or
b. Two cities having contiguous boundaries and constituting, for general economic and social purposes, a single community with a combined population of at least 50,000, the smaller of which must have a population of at least 15,000.

2. If two or more adjacent counties each have a city of 50,000 inhabitants or more and the cities are within 20 miles of each other (city limits to city limits), they will be included in the same area unless there is definite evidence that the two cities are not economically and socially integrated.

The criteria of metropolitan character relate primarily to the attributes of the outlying county as a place of work or as a home for a concentration of nonagricultural workers. Specifically, these criteria are:

3. At least 75 percent of the labor force of the county must be in the nonagricultural labor force.

4. In addition to criterion 3, the county must meet at least one of the following conditions:
a. It must have 50 percent or more of its population living in contiguous minor civil divisions with a density of at least 150 persons per square mile, in an unbroken chain of minor civil divisions with such density radiating from a central city in the area.

b. The number of nonagricultural workers employed in the county must equal at least 10 percent of the number of nonagricultural workers employed in the county containing the largest city in the area, or the outlying county must be the place of employment of at least 10,000 nonagricultural workers.

c. The nonagricultural labor force living in the county must equal at least 10 percent of the nonagricultural labor force living in the county containing the largest city in the area, or the outlying county must be the place of residence of a nonagricultural labor force of at least 10,000.

Total Verified Coliforms -- Microorganisms that include a heterogeneous grouping of bacteria which are identified by bacteriological procedures to produce aldehydes on Endo media at 35°C and were shown to ferment lactose with gas production within 48 hours at 35°C in either aerobic or facultative anaerobic environments. Because these bacteria are eliminated in large numbers in fecal wastes, they have been the traditional bacteriological tool used to measure the occurrence and intensity of contamination in water supplies.

Water Supply -- Water supply system includes the works and auxiliaries for collection, treatment, storage and distribution of water from the sources of supply to the free-flowing outlet of the ultimate consumer. Water supplies were included in this study, if they had 15 or more service connections and/or served 25 or more consumers.

Special Water Supplies - are those supplies serving trailer and mobile home parks and institutions with resident populations.

Community Water Supplies - are all other supplies studied in an SMSA.

## Procedure for Evaluating Water Supply Systems

During the Community Water Supply Study each water supply system was given an overall rating based on the water quality measured during the study and an evaluation of the reliability of the system.

### Water quality

First, the water quality produced and distributed by a water supply was measured by taking samples from the system for chemical and bacteriological analyses. Based on the average values of these results, the water quality in question was given one of five ratings. These were:

(2) Good. - Water quality that meets, on the average, the constituent concentration limits stated in U. S. Public Health Service 1962 Drinking Water Standards.[2] The concentration limits for the constituents measured in this study are summarized in Table II.

### TABLE II

Partial List of Constituent Concentration Limits Taken from the 1962 U. S. Public Health Service Drinking Water Standards

RECOMMENDED

| Constituent | Standard |
|---|---|
| Alkyl Benzene Sulonate (Measured as methylene-blue-active substances) | 0.5 mg/l |
| Arsenic | 0.01 mg/l* |
| Chloride | 250 mg/l |
| Color | 15 units |
| Copper | 1 mg/l |
| Carbon-Chloroform Extract (CCE) | 0.200 mg/l |
| Cyanide | 0.01 mg/l |

| | |
|---|---|
| Fluoride | |
| Temp.(Ann. Avg. Max. Day, 5 years or more) | |
| 50.0 - 53.7 | 1.7 mg/l |
| 53.8 - 58.3 | 1.5 mg/l |
| 58.4 - 63.8 | 1.3 mg/l |
| 63.9 - 70.6 | 1.2 mg/l |
| 70.7 - 79.2 | 1.0 mg/l |
| 79.3 - 90.5 | 0.8 mg/l |
| Iron | 0.3 mg/l |
| Manganese | 0.05 mg/l |
| Nitrate | 45 mg/l |
| Radium-226 | 3 uuc/l (pc/l)*** |
| Strontium-90 | 10 uuc/l (pc/l)*** |
| Sulfate | 250 mg/l |
| Total Dissolved Solids (TDS) | 500 mg/l |
| Turbidity | |
| Untreated | 5 Units |
| Treated by more than disinfection | 1 Unit |
| Zinc | 5 mg/l |

## MANDATORY

| | |
|---|---|
| Arsenic | 0.05 mg/l |
| Barium | 1.0 mg/l |
| Cadmium | 0.01 mg/l |
| Chromium (Hexavalent) | 0.05 mg/l**** |
| Coliform organisms (Measured by membrane filter technique) | Arithmetic average of samples collected greater than 1 per 100 ml***** |
| Cyanide | 0.2 mg/l |
| Fluoride | |
| Temp (Ann.Avg.Max.Day - 5 years or more) | |
| 50.0 - 53.7 | 2.4 mg/l |
| 53.8 - 58.3 | 2.2 mg/l |
| 58.4 - 63.8 | 2.0 mg/l |
| 63.9 - 70.6 | 1.8 mg/l |
| 70.7 - 79.2 | 1.6 mg/l |
| 79.3 - 90.5 | 1.4 mg/l |
| Gross Beta activity (In the absence of or Sr-90 | 1,000 uu c/l (pc/l*** |
| Lead | 0.05 mg/l |
| Selenium | 0.01 mg/l |
| Silver | 0.05 mg/l |

---

*Although the recommended arsenic concentration is 0.91 mg/l, because of interferences in some waters, the concentration of arsenic was only determined to be less than 0.03 mg/l. For the purposes of this study, these waters were considered to meet the recommended standard. **Was not included in the 1962 USPHS Standards.[3] ***If these limits are exceeded, refer to Section 6.2 to PHS Publication No. 956, the 1962 USPHS Drinking Water Standards.[2] ****Total chromium was measured and all considered to be hexavalent chromium. *****This standard was adapted from the 1962 USPHS Drinking Water Standards[2] for this study.

(3) Fair. Water quality that

exceeds, on the average, at least one of the recommended constituent concentration limits from the USPHS 1962 Drinking Water Standards as listed in Table II above, but meets the mandatory constituent concentration limits of the USPHS 1962 Drinking Water Standards.

(4) Poor. Water quality

in which, on the average; 1) at least 25 percent (5 or more) of the average constituent concentrations exceed the recommended constituent concentration limits from the USPHS 1962 Drinking Water Standards as listed in Table II; or 2) one or more of the average concentrations of the constituents markedly exceeds the recommended constituent concentration limits as listed in Table II; but 3) meets the mandatory constituent concentration limits as listed in Table II.

(5) Undesirable. Water quality in which; 1) at least one of the average constituent concentrations exceed the mandatory constituent concentration limits from the USPHS 1962 Drinking Water Standards as listed in Table II; 2) or at least 25 percent (3 or more) of the maximum constituent concentrations, use 4/100 ml as the coliform criterion, exceed the mandatory constituent concentration limits as listed in Table II; or 3) one or more of the maximum constituent concentrations (neglecting coliform) markedly exceeds the mandatory constituent limits as listed in Table II. Water of this quality represents a potential hazard to the health of consumers and the further use of this water for drinking and culinary purposes should be evaluated by the appropriate authority.

## Reliability - Risk

Second, during the study, one or more engineers investigated each water supply system to determine its reliability. This was done in an effort to determine whether or not the water supply system could be expected to continue producing water of the quality that was found during the study. Each of the five components of the system; source, treatment, distribution system, operation and operators, and surveillance program was examined for reliability. An important factor in establishing the reliability of a water supply system was the previous years' water quality data obtained from state health department records.

A water supply system that had an adequate, well-protected, good quality source; had proper treatment; had a good distribution system free from hazards such as cross-connections and open distribution reservoirs; had well trained water treatment operators and maintenance personnel who did their jobs properly; and had satisfactory surveillance over the water quality provided to consumers was considered to be a reliable water supply that contained very little risk of failure. The chances of multiple failures within the components of such a system occurring at once, thereby providing low quality water to consumers, is minimal. Such a water supply was given a risk rating of excellent.

Reduced reliability in one of the five components in the system does not necessarily mean that low quality water will be provided to consumers, but it does mean that a greater burden of protection is placed on the other components of the system, and that the chance for failure (providing low quality water) is increased. For example, problems would be less likely to develop in a distribution system with both a free chlorine residual and cross-connection control program, than in one in which the burden of protection was entirely on the free chlorine residual. As the number of water supply system deficiencies increases, the chance of providing low quality water to consumers also increases, and such water supply systems were given lower risk ratings.

In summary, the reliability of water supply systems were given one of four risk ratings as follows:

| Reliability | Risk Rating |
|---|---|
| 1) Minimal risk - | Excellent |
| 2) Acceptable risk - | Good |
| 3) Intermediate risk - | Fair |
| 4) High risk - | Poor |

These risk ratings are admittedly subjective, but were based on the engineering judgments of the professionals making the evaluations.

## Overall rating

The overall rating of a water supply system is the lower of the two ratings, the water quality rating and the risk rating. This means that a well-run system that produced low quality water would be downrated on a water quality basis, while a system providing a satisfactory quality water at the time of the study, but one that contained a deficiency or deficiencies in the system that increased the chance that consumers might receive low quality water at some other time, would be downrated on a reliability basis. To help the reader determine whether the overall rating of a given water supply system was based on its water quality rating or risk rating, the major deficiency or deficiencies for each system with an overall rating of fair, poor, or undesirable is listed in the Summary Table of Water Supply Evaluations. Table III summarizes this evaluation procedure.

In the certification of water supplies for use on interstate carriers the Public Health Service normally uses a three level classification system, i.e., APPROVED, PROVISIONALLY APPROVED and PROHIBITED.

An APPROVED classification means that a supply is approved for a twelve-month period to serve interstate carriers. It does not mean, however, that the system is free of all defects. Usually, several deficiencies (not yet of a potential public health hazard) are noted and action on the recommendations resulting from these deficiencies is expected before the next annual inspection.

A PROVISIONAL classification is usually the result of major deficiencies (potential public health hazards) in the plant or system, poor sampling programs, lack of a plumbing control program or failure to act on recommendations of a previous inspection. A provisional classification carries with it a definite expiration date at which time all recommendations are expected to be satisfied.

A PROHIBITED classification is the result of gross deficiencies immediately hazardous to public health or failure to act on recommendations given with a Provisional classification. A Prohibited supply may not serve interstate carriers.

To reconcile the two classification systems presented above, the basic guidelines for each system should be used. A supply of high risk potential or undesirable water quality would be Prohibited for use on interstate carriers, an intermediate risk supply, or one with Fair water quality, would be Provisionally Approved, Good and Excellent supplies would be Approved.

## TABLE III

## Summary of Evaluation Procedure

| Water Quality Determined During Study | Water Quality Rating | Reliability | Risk Rating | Overall Water Supply System Rating |
|---|---|---|---|---|
| Avg. meets USPHS standards | Good | Acceptable Risk | Good | LOWEST OF THE TWO RATINGS |
| One or more avg. constituents exceeds recommended USPHS standards, but meets mandatory USPHS standards | Fair | Intermediate Risk | Fair | |
| 25% or more avg. constituent exceeds recommended USPHS standards; or one or more avg. constituent markedly exceed recommended USPHS standards; but meets mandatory USPHS standards. | Poor | High Risk | Poor | |
| One or more avg. constituents exceeds mandatory USPHS standards; or 25% or more maximum constituents exceed mandatory USPHS standards; or one or more maximum constituents (neglecting coliform) markedly exceeds mandatory USPHS standards. | | | | |

1. Anon. "Quality Goals for Potable Water." Journal of the American Water Works Association, 60, 1317-1322

2. Public Health Service Publication No. 956, Superintendent of Documents, Government Printing Office, Washington, D. C. 20402.

3. Manual for Evaluating Public Drinking Water Supplies, Public Health Service Publication No. 1820, Superintendent of Documents, Government Printing Office, Washington, D. C. 20402.

## Results and Discussion

### Classification of Supplies

215 supplies have been rated according to the above guidelines: No supplies were rated Excellent; 8 community supplies and one special supply serving a total population of 14,668 were rated Good; 61 community supplies and 9 special supplies serving a total population of 188,226 were rated Fair; 65 community supplies and 3 special supplies serving a total population of 41,780 were rated Poor; and 66 community supplies and 2 special supplies serving a total population of 33,555 were rated Undesirable or Unfit to Drink.

(Table 1 summarizes the supplies surveyed, population served, type of supply, major deficiencies, overall rating, and pertinent remarks.)

As discussed in the earlier section, "Procedure for Evaluating Water Supply Systems", areas of water quality and risk were evaluated separately and an overall rating was given. All 6 8 Undesirable ratings were given on the basis of water quality. The other rating classifications reflected both water quality and risk.

This means that for approximately half the supplies surveyed, the risk of potential health hazard is great even though the water quality was good at the time of the survey.

When the survey was made, the PHS Engineers rated the supplies as if they were being classified for use on interstate carriers. These ratings resulted in 16 Approved supplies; 130 Provisionally Approved supplies; and 71 Prohibited supplies.

## State Program

Legal basis for the water supply sanitation program of the Vermont State Health Department is scanty. State statutes loosely give the Health Department responsibility for surveillance of all public water supplies but virtually no power to obtain improvements thereof. Chapter 5, Sanitary Engineering, of Vermont Health Regulations does give the Health Department a certain control over water quality by requiring approved water supplies at hotels, restaurants, tourist houses, cabin camps, vacation camps, roadside stands, public buildings, food establishments, bakeries, and migrant labor camps. Plumbing is also regulated by this chapter. Approved is understood to mean a supply which generally meets the Public Health Service Drinking Water Standards.

Effectiveness of the state program has been severely hampered by lack of personnel. For the past 3 years both the State Sanitary Engineer and the Commissioner of Health have requested funds for an improved water supply surveillance program. Each time the legislature has refused this request. As a result, the condition of water supplies in the State has deteriorated markedly. The laboratory division has sent bacteriological sample bottles to most of the water supplies in the state, however, there is no follow-up on whether or not they are sent to the correct person or are used. In Vermont, samples can be taken by the local health officer, the selectman, the prudential committee or the operator. Results are sent to the person sending the sample. If there is little or no contact between the persons involved with the water supply, results are often buried and are unknown. This situation is very common. Analytical results from municipal water supplies are sent to the Bureau of Environmental Sanitation. They are reviewed and entered in a record book. There has been little follow-up on bad samples or on insufficient or no samples submitted. The record book indicates recurring bad samples month after month with no action taken. The two engineers of the Bureau have not been able to get into the field as they have been literally swamped with day to day office duties such as handling complaints, reviewing plans and supervising the sanitarians, defending standards as well as other programs for which they have responsibility, such as solid waste disposal. As a result, the most effective means of improving water supplies; field inspection and consultation, has suffered. 95% of the supplies visited by the CWSS survey team reported that they had not had a visit or survey made by the State in the past 3 years. Many operators of the systems visited expressed the thought that routine visits by State Engineers would be much appreciated.

There is only one person in the Health Department assigned to plumbing control activities. These include administration of Plumber's Licensing

Program and enforcement of the State Plumbing Code. These cross-connection activities are handled by the above mentioned engineers and as such, is not given the emphasis needed. A brief survey in Burlington revealed a number of cross connections, indicating the need for a cross-connection control program. Generally, people in the field were not aware of dangers of cross-connections or of means of implementing a cross-connection program.

50<

## General Description of Water Supply Systems

Vermont's 217 water supply systems represent treatment types ranging from no treatment to complete coagulation-filtration systems. The total population served is approximately 281,000. Four supplies serve over 10,000 each (10,387 to 45,000), 50 supplies serve over 1,000, and 46 supplies serve less than 100 people. Thus, over half the supplies in Vermont serve between 100 and 1,000 persons.

Most supplies in the state are very simple utilizing mountain brooks and springs feeding without treatment directly into the distribution system. Plentiful supplies of water in the mountains and low population has made this type of system very economical and convenient to construct and operate. As the above figures indicate, the majority of the supplies are quite small. Many of them have grown from individual supplies to community supplies as the village or community grew. Control is usually by a committee of members of the community. Very little is done in the way of surveillance. Trust in "pure" natural sources has supplanted the need for sampling, treatment and watershed protection in the minds of most of the people.

## Facilities Appraisal

Water supply systems in Vermont are either simple spring fed systems, systems using streams and ponds with or without disinfection, or complete coagulation-filtration plants. In Vermont, however, the vast majority (97%) are of the first two types. Of the 217 supplies surveyed, only 89 had any treatment at all and this only simple disinfection for all except 32 supplies. 14 supplies utilize filtration of some sort. A large majority of the supplies surveyed were found to be inadequate in the major areas of water supply. From CWSS data -

50 of 57 supplies utilizing disinfection were inadequate in provision of standby chlorination, i.e., there was none;

103 supplies were inadequate in provision of adequate storage on the distribution system. Usually, there was none at all;

35 supplies were inadequate in water transmission and distribution lines;

35 supplies could by-pass t5eatment units;

72 supplies were inadequate in maintenance; and

71 supply systems failed to maintain adequate pressures under heavy use. The major reasons for these inadequacies is lack of attention by the State Health Department and inability to finance improvements due to low rates, along with lack of appreciation of the need for improvements.

The systems generally exhibit the effects of long term neglect.

### Sources

The major sources of supply for the water supply systems in Vermont are mountain springs, brooks, and ponds and small wells. Thought to be "pure" due to their remote location, these sources have long been used for water supply purposes without treatment or maintenance. Changing watershed use and deterioration of structures has resulted in a situation in which 123 supplies were found to have sources inadequately protected. Deficiencies found during the survey included lack of watershed control (intrusion by deer hunters is very common), deterioration of spring collection boxes (allows contaminated surface water to enter spring), poor well seals, and recreational use of the source.

Little is known of the quality of the raw water sources. Only 4 supplies routinely monitor their sources. Bacteriological samples are not taken frequently, if at all, for most supplies and routine chemical and physical analyses are unheard of. In fact, one of the larger supplies (Newport) has planned and ordered fluoridation equipment without a recent raw water fluoride analysis! This lack of raw water monitoring will make future planning of treatment most difficult, even hazardous!

There is also a disturbing trend of development of recreational use of water supply sources. Five supplies utilize ponds for the majority of their water supply. Usual treatment is marginal disinfection. Other state agencies have promoted development of these ponds through construction of fishing accesses and promotion of recreational use such as swimming. Supplies utilizing Lake Champlain as a source also are subject to recreational use of the lake in the vicinity of the water supply intakes.

## Bacteriological Evaluation

In evaluating bacteriological data for Vermont the existing state monitoring program (numbers of samples and results) and CWSS results were considered. During the 12 months preceding the survey, 192 of the 220 supplies covered failed to submit sufficient numbers of monthly samples and 170 supplies did not submit any samples in one or more months. 64 supplies did not submit any samples at all. Of the supplies which did submit samples for examination, 104 supplies failed to meet Drinking Water Standards quality requirements in one or more months.

In many cases, supplies had poor quality month after month. For the most part, the smaller supplies (population less than 500) were the worst offenders in not submitting any samples at all.

A disturbing conclusion which can be reached from this is that since most of these supplies do not treat their water there is no margin of safety in protection of the consumer from potential water borne disease outbreaks.

Samples taken during the CWSS highlight the seriousness of the situation. Of 461 samples taken from distribution systems, 23% of the samples contained more than one coliform, 18% contained more than 2 coliforms, and 17% of the samples contained one or more fecal coliform. In one case, a sample contained a fecal coliform content of 93 per 100 ml. Of the samples which contained greater than 2 coliforms and one or more fecal coliform, 77% of the companion samples - samples taken from the same distribution system - were also positive. When no fecal coliforms were present, less than 50% of the comparison samples were positive. This indicates that when fecal contamination is found, the chances are 77 of 100 that the entire distribution system was contaminated. 17% of the supplies in the state fit into this category.

The major reason for this situation is lack of disinfection. In no case where adequate disinfection was practiced were bad bacteriological samples found.

## Chemical Evaluation

Since recent chemical data for most of the supplies surveyed was not available, the main source of data used in evaluation of the chemical quality of the supplies surveyed was results obtained from samples taken during the survey.

As would be expected from soft, untreated supplies, typical of most of those surveyed, the water distribution systems and home plumbing systems showed evidence of deterioration from action of such agressive waters. 13 supplies yielded samples which contained lead in concentrations exceeding the mandatory standard. Serious health problems due to lead poisoning could result from prolonged ingestion of these waters. 34 supplies yielded samples exceeding the recommended standard for iron and 45 supplies yielded samples exceeding the recommended standard for manganese. These latter two constituents, while directly not of much health significance, reduce the desirability of using these waters and prompt people to use alternate sources which may be (and probably are) poorer Bacteriologically. A number of supplies also yielded samples exceeding the recommended standard for Copper.

In contrast, physical quality of most of the supplies surveyed was good; only 3 supplies exceeded the recommended color standard and 1 supply exceeded the recommended turbidity standard.

Based on the results of survey samples, treatment requirements for chemical control are minimal. Simple liquid feed units for polyphosphates and chlorine solution could easily be set up in most supplies.

## System Management

Due to their small size, many water supply systems in Vermont are not able to support a full time superintendent. Some supplies have a water committee which watches over the supply, sharing any work that has to be done as it comes up. The most common management unit, however, is the Prudential Committee. This is a committee of 3 to 5 of the townspeople who take care of the water supply, fire department, street lights and sanitary facilities. Since these activities are done after normal working hours, not much of anything is done on the water supply system unless an emergency develops. Most Prudential Committee members know very little about their water supplies. Lack of contact by the State Health Department has resulted in a lack of appreciation for the need for good bacteriological monitoring and watershed protection programs. The old standby of "no fatalities" has generated a false sense of security in these people. As bad as the above seems, however, there are about 75 supplies which have no person in charge at all. In a few cases nobody knew who owned the system or who to pay their bills to.

As a result of this lack of management, many systems just about run themselves, and show it. 72 supplies were listed by the CWSS surveyors as having inadequate maintenance and comments such as "don't do anything until it breaks" were common.

Another aspect of system management is rates charged for water service. Since there is virtually no metering, flat rates are charged for water. Most supplies charge $10 - $20 per year, some charge nothing and a few charge more than $20 per year. Income thus derived is sparse indeed and a frequent complaint of the person responsible for the water supply was that he didn't have enough funds to keep up, much less finance improvements.

There was also a lack of knowledge of available grant programs. The problem which results from this poor management is particularly serious in view of the lack of surveillance provided for the majority of the water supplies.

## Operation and Surveillance

### Operation

Since Vermont does not have a water supply operator certification program or any formal training programs, most of the water supplies in the state are under the control of untrained persons. Two hundred (200) supplies visited were operated by persons without any formal water supply training. What training there has been has been by equipment salesmen except for one or two communities which have sent someone to a New England Water Works training course.

Most operators did not devote full time to water supply operation. In fact, it was necessary for a number of persons to take time off from their regular full time jobs to accompany the PHS engineer on his survey. Low salaries, lack of appreciation for the need, are the primary reason for the lack of adequate operation. In many supplies, the operator received less than $2000 per year for his services. In other supplies the "operator" was paid only by the hours he spent on the system. One person got $2.00 a week for his services. Some are not paid anything at all. Lack of enough time to spend on the supply has resulted in a serious lack of maintenance and attention to chemical feed when used. In a number of instances, the storage crocks for hypochlorinators or chlorine gas cylinders, were found to be empty during the CWSS survey. 72 supplies were rated inadequate in maintenance. In some cases very severe deterioration of spring boxes, storage basin roofs, chlorinators and valves was observed.

In almost all cases, new lines and repairs were not disinfected and sampled before being put in service. Most supplies flush and a few add a chlorine compound but none take check samples. Generally, the system operators exhibited a total lack of awareness of any need for disinfection and sampling.

### Surveillance

Surveillance at the local level is virtually non-existent. The State Department of Health Laboratory in Burlington is the only certified laboratory in the State and the water supplies have been asked to use this laboratory only. There has been little push to develop a system sampling program, as such, at the operator level and as a result, many operators do not take samples nor are they aware of any sampling done on their systems.

Operation monitoring is scanty. In 40 of the supplies which had treatment, inadequate treatment operation records were kept. Chlorine cylinders were not on scales, amounts of hypochlorite and poly-phosphate used were not recorded and chlorine residuals and pH's were not run or recorded.

Generally, operation of most systems in Vermont consists of repairing (or arranging for repairing) leaks and breaks and installing new lines. Surveillance of distribution systems for cross-connections is almost non-existent. In no case was there a regular program of system inspection for the detection and elimination of cross-connections. Public Health Service Survey Engineers noted the possibility of cross-connections in 10 supplies, indicating the need for a cross-connection program.

In many of the supplies, cross-connection surveys are not necessary. These would be the supplies which are entirely residential, serving limited areas. Here, simple public education should be sufficient. There are supplies, however, which serve sewage treatment plants, plating works, dairies, etc. These supplies should develop, with State Health Department assistance, a cross-connection survey program with the aim of detecting and eliminating cross-connections.

Coupled with inadequate surveillance on the State level, lack of local surveillance adds up to a very dangerous situation as the major lines of defense against waterborne disease, source protection, treatment, operation and surveillance are missing. Ghe generally remote nature of the area and a poor epidemiological surveillance program are undoubtedly the major reasons why there have been few reports of waterborne disease outbreaks.

## Consumer Acceptance

One of the items covered during the sanitary survey was an appraisal of customer complaints. A surprising result was obtained. In only 27 cases did customers express dissatisfaction with the quality of their water supply. 15 of these complaints were for chlorine taste. The people of Vermont, almost to a man, believe that their water, obtained from mountain springs and brooks, is the best water in the world. Even when confronted with bad sample results (both physical and bacteriological), this belief still persists. Over and over again the statement "no one has died (or gotten sick) from drinking our water" was made to members of the survey crew. This attitude, coupled with tight finances, makes it very difficult to obtain improvements.

## Waterborne Disease

Waterborne disease has been a problem at times in the State of Vermont. Lack of epidemiological studies makes an exact evaluation of the situation difficult, however, available reports of waterborne disease outbreaks are significant.

In November 1963 over 300 cases of gastroenteritis were reported in Island Pond. Subsequent investigations strongly implicated the untreated water supply as the source of transmission of the disease. Since then, there have been reports (one made to the CWSS survey engineer) that a substantial number of "stomach ailments" arise in school children after strong rainstorms. Water quality is observed to deteriorate after these storms, indicating a possible cause-effect relationship. The above outbreak is significant because the Island Pond water supply is typical of many water supplies in Vermont. (It should be noted that plans for disinfecting Island Pond's water supply are presently being carried out ).

In July, 1969, over 130 cases of gastroenteritis were reported at a girls' camp. Water taps with contaminated lake water as a source were implicated as the source of transmission of two outbreaks of the disease during July. This type of system is typical of many supplies in camping areas. While the source of drinking water was a protected spring; water supposedly not for drinking was easily available.

There have been other unsubstantiated reports of water borne outbreaks in institutions utilizing untreated water supplies.

Untreated water supplies have been responsible for transmission of waterborne disease in Vermont. The survey revealed many untreated water supplies with water of bad bacteriological quality. There have been few reports or investigations of cases of "stomach flu", etc., which undoubtedly occur often. It is possible that water supply systems are responsible for these cases. There is a need for intensive epidemiological study in this area to determine what role the untreated water supply system plays in the transmission of water borne disease in Vermont.

# APPENDIX I

## PERTINENT CORRESPONDENCE

ROBERT B. AIKEN, M.D. M.P.H.
COMMISSIONER

OFFICE OF THE COMMISSIONER

**STATE OF VERMONT**
**DEPARTMENT OF HEALTH**
115 COLCHESTER AVENUE
BURLINGTON 05402

June 11, 1969

Mabel Ross, M.D
Regional Health Director
U.S. Public Health Service
J.F. Kennedy Federal Building
Boston, Massachusetts

Dear Dr. Ross:

At a recent meeting of our Interagency Council on Natural Resources, some facts which we had known for some time finally became public property in regard to the lack of policing and control of many of the surface water supplies in Vermont. Both the Governor and Lieutenant Governor interested themselves in this, and simultaneously I was aware of the fact that a Public Health Service Team was in the process of doing a survey in regard to the quality of water supplies in the United States.

I have spoken to Floyd Taylor about this, and he suggested I contact you. I understand that a team might be available, and another engineer would be available to come to Vermont in advance of the team to set up a survey in Vermont. In a conference requested by the Governor this morning, I spoke to him about this possibility, and he expressed a great deal of enthusiasm, and said he hoped we would be able to obtain such a team from the Public Health Service.

Consequently, I am requesting that the Public Health Service assist the State of Vermont in setting up this survey. It also would appear to me that this could be of assistance to the Public Health Service in their nationwide survey as an example of rural and semi-rural population surrounded by several million potential tourists and recreation visitors.

I sincerely hope you can grant this request.

Sincerely,

R. B. Aiken, M.D
Commissioner of Health

RBA:LG

UNITED STATES GOVERNMENT

*Memorandum*

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
REGIONAL OFFICE

TO : Frank Tetzlaff
Regional Assistant Administrator, CPE

DATE: June 17, 1969

FROM : Floyd B. Taylor, Regional Representative
Bureau of Water Hygiene

REFER TO:

SUBJECT : Trip Report - Burlington, Vermont

Purpose of Trip - To confer with the Commissioner and Chief Engineer of the Vermont State Department of Health regarding a public health survey of water supplies in that State.

The writer met with Dr. R. Aiken and Mr. John Richards on June 12, 1969 to discuss the details of the Public Health Service survey of Vermont water supplies which Dr. Aiken has requested. Important points of the discussion are as follows:

1. There has been public concern about the use of surface water supplies for drinking purposes which same supplies are also extensively used for recreation.

2. The Vermont press has carried several articles about this and also about who is basically responsible for water supply sanitation in Vermont. The Water Resources Commission and the State Health Department are the two parties involved. It is Governor Davis' opinion that the area of drinking water supply definitely is the responsibility of the Health Department.

3. Vermont Health Department has been unusually understaffed and unable to make inspections of water supplies for several years. Samples have been analyzed and results reported but that is the extent of it.

It was found that the Division of Sanitary Engineering has repeatedly requested additional staff to handle the work of water supply and Dr. Aiken stated that he has requested 4 governors for funds with which to do this kind of work. Such funds have not been allotted.

While the writer was there he conferred with Mr. Lee McCabe, Director of the National Community Water Supply Study, and Mr. William Long, Deputy Director of the Bureau of Water Hygiene. A decision was reached

HELP ELIMINATE WASTE HEW COST REDUCTION PROGRAM

GPO : 1968 O—797-836

to relocate the Region I part of the Community Water Supply Study and perform an intensive survey of Vermont's water supply during July. New Haven County will be postponed. Mr. McCabe authorized the re-direction of Mr. Smith's services for the weeks of June 16 - 27, 1969. Instead of going to New Orleans, Mr. Smith will be the advance guard of the Vermont Study and will spend those two weeks laying the ground work for it.

Dr. Aiken invited the writer and together with John Richards and Mr. Harold Parsons and the State Health Department public relations persons, went to Dr. Aiken's home along Lake Champlain where the survey and its purposes were discussed for a few hours. Dr. Aiken stated that he would formalize his request in a letter to Dr. Ross and that he was delighted with the promptness and extent of the Public Health Service response to his request for help. He said that the timing was particularly important because he can then use the results of the survey in his recommendation to the Vermont Legislature and the Governor for legislation and resources with which to strengthen the water supply effort in the work of his Department.

Floyd B. Taylor

Floyd B. Taylor

ROBERT B. AIKEN, M.D., M.P.H.
COMMISSIONER

OFFICE OF THE COMMISSIONER

**STATE OF VERMONT**
**DEPARTMENT OF HEALTH**
115 COLCHESTER AVENUE
BURLINGTON 05401

August 28, 1969

Mr. Frank Tetzlaff
Assistant Regional Director for Environmental Health
Department of Health, Education, and Welfare
John Fitzgerald Kennedy Federal Building
Boston, Massachusetts 02203

Dear Frank:

I have been reviewing the Public Health Service water studies in Vermont, and I don't think there is any question we are in what amounts to an emergency situation with 30% of the public water supplies contaminated and unfit for human consumption. We are presently so understaffed that we simply cannot keep up with our duties in the field of environmental control. The situation is becoming more desperate daily.

In view of the seriousness of the situation, I am urgently requesting the loan of two Public Health Service engineers to handle the water situation and especially, incidentally, to help us with underground sewage disposal, as it may affect water pollution. I would hope these would be only on a temporary basis, since the Board has asked me to try to get funds from our own Emergency Board. However, this takes time - frequently months - especially when it is close to legislature.

I would appreciate it if you can help us.

Sincerely,

Bob

R. B. Aiken, M.D.
Commissioner of Health

RBA:mb
cc: Mr. John Richards
cc: Mr. Floyd Taylor

## APPENDIX II

## PRINTOUT OF RESULTS

# APPENDIX III

## FORMS USED TO GATHER DATA

FCA-10 (FIN)
(2-69)

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Consumer Protection and Environmental Health Service
Environmental Control Administration
Bureau of Water Hygiene

## INVENTORY OF MUNICIPAL WATER FACILITIES

LATEST DATA IN PHS FILES

68<

| COMMUNITY | POPULATION<br>ESTIMATED POPULATION SERVED | YEAR OPER. STARTED<br>PRESENT SUPPLY<br>PRESENT TREATMENT PLANT | OWNERSHIP |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| | | | |

| NUMBER OF SERVICES<br>NUMBER OF METERS | LAB. CONTROL | SOURCE OF SUPPLY | SAFE YIELD IMPOUNDED MG<br>MAXIMUM DEPEND. DRAFT (GR. WATER) MG |
|---|---|---|---|
| 5 | 6 | 7 | 8 |
| -- | | | |

| RATED PLANT CAPACITY MGD<br>AVERAGE PLANT OUTPUT MGD | TREATMENT | DISTRIBUTION STORAGE<br>PUMPED TO MAINS | IMPROVEMENTS NEEDED |
|---|---|---|---|
| 9 | 10 | 11 | 12 |
| | | | |

CURRENT DATA

STATE

| COMMUNITY OR FACILITY<br>Correct legal name<br>LOCATION (1) a<br>Postal address of utility | 1960 CENSUS POPULATION (2) a<br>CURRENT ESTIMATED POPULATION SERVED (2) b | LAB. CONTROL (3) | OWNERSHIP (4) |
|---|---|---|---|
| COUNTY (1) b | | | |
| | | | |

| (5) CLASSIFICATION | NUMBER OF SERVICES | NUMBER OF METERS | MGD AVG. WATER | SOURCE OF SUPPLY (6) | SAFE YIELD IMPOUNDED MG (7) a<br>MAXIMUM DEPENDABLE DRAFT (GR. WATER) MG (7) b |
|---|---|---|---|---|---|
| RESIDENTIAL a | | | | | |
| COMMERCIAL b | | | | | |
| INDUSTRIAL c | | | | | |
| PUBLIC d | | | | | |
| TOTAL e | | | | | |

| RATED CAPACITY MGD (8) a<br>AVERAGE (8) b OUTPUT MGD<br>EMERGENCY POWER (8) c | TREATMENT (9) a | DIST. STORAGE<br>PUMPED TO MAINS MG (10) a<br>GRAVITY TO MAINS MG (10) b | IMPROVEMENTS NEEDED (11) |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

REMARKS

MUNICIPAL WATER SUPPLY SANITARY SURVEY

BOB #85-S69004
Exp. March 1970

1. Leave this blank 1 12 (for office use only) (DUP. ON EVERY CARD)

SURVEY DATE Date of your VISIT 13 mo. day yr. 18

2. Name of supply Same as on inventory

3. Location Same as on inventory
post office common name, if different

4. Demands, MGD:

| | PRESENT | 10-YR. ESTIMATE | UNKNOWN |
|---|---|---|---|
| A. Avg. day | From 7 23 | ☐☐☐☐☐ 24 28 | ☐ 30 |
| B. Max. day | Plant 31 35 | ☐☐☐☐☐ 36 40 | ☐ 42 |
| C. Max. month | Records 43 47 | ☐☐☐☐☐ 48 52 | ☐ 54 |

5. Water use has been restricted ☐☐ 55 56 times for a total of ☐☐☐ 57 59 days during any one year of the past 5 years.

6. LABORATORY CONTROL

A. Bacteriological (Distribution system only)

From Fig 1 - D.W.S

From plant records

| | | UNKNOWN |
|---|---|---|
| (1) Min. number samples recommended per month by PHS DWS → | ☐☐☐ 60 62 | |
| (2) Avg. number/month for last 12 months | ☐☐☐ 63 65 | ☐ 67 |
| (3) Range of least and most monthly samples from May be zero 68 70 to | ☐☐☐ 71 73 | ☐ 75 |

END CARD ONE 1 80

(4) Number of months the Drinking Water Standards were not met during the last 12 months for: No. of months

| | | UNKNOWN |
|---|---|---|
| (a) Quality — Sec 3.2 - D.W.S. | ☐☐ 13 14 | ☐ 15 |
| (b) Number of samples {Months when sample numbers < no. in 6.A.(1) | ☐☐ 16 17 | ☐ 18 |
| (c) NONE collected No samples for ___ months. | ☐☐ 19 20 | ☐ 21 |

| | | |
|---|---|---|
| (5) Are samples representative of distribution system? Judge from map of distribution system. | ☐ 22 yes | ☐ 23 no |
| (6) Are check samples collected as provided for in the Drinking Water Standards? Sec 3.15 - D.W.S. | ☐ 24 yes | ☐ 25 no |
| (7) Are samples requiring check samples reported by telephone? | ☐ 26 yes | ☐ 27 no |
| (8) Is the laboratory certified? | ☐ 28 yes | ☐ 29 no |
| (a) Within the past 3 years? | ☐ 30 yes | ☐ 31 no |
| (b) If "yes" to one or both, by whom was it certified. | ☐ 32 State | ☐ 33 PHS |
| (9) Are samples received by lab within 30 hours? | ☐ 34 yes | ☐ 35 no |

Information from operator

A-19

-3- Name on each page

2

B(1)-(4) refer to Sec. 5.2 - DWS.

B. Chemical (finished water only)

(1) Samples of finished water are analyzed each ☐ 36 month, ☐ 37 year,
☐ 38 2 years, ☐ 39 3 years, ☐ 40 infrequently ☐ 41 never.

(2) Type of analysis: ☐ 42 everything complete (DWS) ☐ 43 partial. If any constituen misse

(3) Date of last chemical analysis ☐☐ 45 mo. ☐☐ day ☐☐ yr 50

(4) Analyzed by ☐ 51 utility, ☐ 52 state, ☐ 53 PHS, ☐ 54 university, ☐ 55 other.

(5) Tests run for operational control and their frequency are:

| Tests | Continuous | Each shift | Daily | Weekly | Less frequently than weekly |
|---|---|---|---|---|---|
| Alkalinity | ☐ 57 | ☐ | ☐ | ☐ | ☐ 61 |
| Aluminum | ☐ 62 | ☐ | ☐ | ☐ | ☐ 66 |
| Chloride | ☐ 67 | ☐ | ☐ | ☐ | ☐ 71 |
| Chlorine residual (END CARD TWO) 2 80 | ☐ 72 | ☐ | ☐ | ☐ | ☐ 76 |
| Color | ☐ 13 | ☐ | ☐ | ☐ | ☐ 17 |
| Fluoride | ☐ 18 | ☐ | ☐ | ☐ | ☐ 22 |
| Hardness | ☐ 23 | ☐ | ☐ | ☐ | ☐ 27 |
| Iron | ☐ 28 | ☐ | ☐ | ☐ | ☐ 32 |
| Jar tests | ☐ 33 | ☐ | ☐ | ☐ | ☐ 37 |
| Manganese | ☐ 38 | ☐ | ☐ | ☐ | ☐ 42 |
| pH | ☐ 43 | ☐ | ☐ | ☐ | ☐ 47 |
| Taste & Odor | ☐ 48 | ☐ | ☐ | ☐ | ☐ 52 |
| Turbidity | ☐ 53 | ☐ | ☐ | ☐ | ☐ 57 |
| Zeta potential | ☐ 58 | ☐ | ☐ | ☐ | ☐ 62 |
| Other ________ | ☐ 63 | ☐ | ☐ | ☐ | ☐ 67 |

Note other frequencies

C. Radioactivity

(1) Samples are analyzed each ☐ 69 month, ☐ 70 year, ☐ 71 2 years, ☐ 72 3 years,
☐ 73 infrequently ☐ 74 never. (END CARD 3) 3 80

(2) Date of last radiological analysis ☐☐ 13 mo. ☐☐ day ☐☐ yr 18

(3) Analyzed by ☐ 19 utility, ☐ 20 state, ☐ 21 PHS, ☐ 22 university, ☐ 23 other. (specify)

70<

7. SANITARY SURVEY

A. Date of most recent survey ☐☐ mo. 28 ☐☐ day ☐☐ yr. 29 of ☐ 30 no. By others - Not this one

B. Survey made by: ☐ 31 state, ☐ 32 PHS, ☐ 33 local health department,
☐ 34 utility, ☐ 35 consultant. "Survey" requires written report of findings

C. Facilities surveyed: ☐ 36 source, ☐ 37 transmission, ☐ 38 treatment,
☐ 39 storage, ☐ 40 distribution.

8. FACILITIES & OPERATION (describe deficiencies on reverse side)

| | YES | NO |
|---|---|---|
| A. Are there common walls between finished and lesser quality water? | ☐ 41 | ☐ 42 |
| B. Are there inter-connections to other "systems" {Sub-divisions, private industrial, community | | |
| (1) of known acceptable quality indicated by state health dept acceptance. | ☐ 43 | ☐ 44 |
| (2) of unknown quality | | |
| (a) with protection Note how protected | ☐ 45 | ☐ 46 |
| (b) without protection | ☐ 47 | ☐ 48 |
| C. Is there a cross-connection control program | | |
| (1) on new construction only | ☐ 49 | ☐ 50 |
| (2) for continuous re-inspection | ☐ 51 | ☐ 52 |
| D. Are finished water reservoirs properly covered? | ☐ 53 | ☐ 54 |
| E. Is there detectable chlorine residual in distant parts of the distribution system? | ☐ 55 | ☐ 56 |
| F. Can the treatment plant be by-passed? | ☐ 57 | ☐ 58 |
| G. Are there satisfactory procedures to: | | |
| (1) prevent personal accidents | ☐ 59 | ☐ 60 |
| (2) prevent chlorine accidents | ☐ 61 | ☐ 62 |
| (3) disinfect all new and/or repaired distribution system mains, valves, fittings, including check samples before being placed in service? | ☐ 63 | ☐ 64 |
| H. Are there areas of low pressure ( < 20 psi) in the distribution system under maximum water use? | ☐ 65 | ☐ 66 |

I. Operating problems most often encountered are: ☐ 67 taste & odor
☐ 68 phenols, ☐ 69 corrosive water, ☐ 70 short filter runs, ☐ 71 other, specify.

9

71<

8. FACILITIES & OPERATION, continued

J. Chlorination process was interrupted ☐☐ (72 73) times in the last 12 months.

(1) Interruptions were due to: ☐ (74) chlorinator failure, ☐ (75) feedwater pump, ☐ (76) changing cylinders, ☐ (77) power failure, ☐ (78) other, explain.

(END CARD 4) 4 (80)

K. Percent of land area within service area where water is available (nearest whole percent) ☐☐☐ (13 15) %.

| | YES | NO |
|---|---|---|
| L. Were plans and specs. for treatment plant approved by the state? | ☐ 16 | ☐ 17 |

9. SOURCE, TREATMENT & DISTRIBUTION (describe deficiencies on reverse side) Note

A. Are the following adequate:

| | YES | NO |
|---|---|---|
| (1) Source, with respect to the following: | | |
| (a) quantity | ☐ 18 | ☐ 19 |
| (b) bacteriological quality | ☐ 20 | ☐ 21 |
| (c) chemical quality | ☐ 22 | ☐ 23 |
| (d) physical quality | ☐ 24 | ☐ 25 |
| (e) adequate protection | ☐ 26 | ☐ 27 |
| (2) Transmission of raw water | ☐ 28 | ☐ 29 |
| (3) Is the raw water sampled for: | | |
| (a) Bacteriological contamination | ☐ 30 | ☐ 31 |
| (b) Chemical contamination | ☐ 32 | ☐ 33 |
| (4) Treatment, with respect to the folowing: | | |
| (a) aeration | ☐ 34 | ☐ 35 |
| (b) chemical feed, capacity | ☐ 36 | ☐ 37 |
| (c) chemical feed, stand-by equipment | ☐ 38 | ☐ 39 |
| (d) chemical mixing | ☐ 40 | ☐ 41 |
| (e) flocculation | ☐ 42 | ☐ 43 |

} Refer to PHS No. 1820

72<

9. SOURCE, TREATMENT & DISTRIBUTION, continued

A. Are the following adequate (continued):

| | YES | NO |
|---|---|---|
| (4) Treatment, continued: | | |
| (f) settling | ☐ 44 | ☐ 45 |
| (g) recarbonation | ☐ 46 | ☐ 47 |
| (h) filtration At normal operating rates | ☐ 48 | ☐ 49 |
| (i) disinfection, capacity | ☐ 50 | ☐ 51 |
| (j) disinfection, stand-by equipment | ☐ 52 | ☐ 53 |
| (k) taste & odor control | ☐ 54 | ☐ 55 |
| (l) fluoridation | ☐ 56 | ☐ 57 |
| (5) Distribution, with respect to the following: | | |
| (a) storage | ☐ 58 | ☐ 59 |
| (b) booster chlorination | ☐ 60 | ☐ 61 |
| (c) high service pumping | ☐ 62 | ☐ 63 |
| (d) booster pumping | ☐ 64 | ☐ 65 |
| (e) pressure | ☐ 66 | ☐ 67 |
| (6) Maintenance | ☐ 68 | ☐ 69 |
| (7) Records for: | | |
| (a) disinfection | ☐ 70 | ☐ 71 |
| (b) filter runs | ☐ 72 | ☐ 73 |
| (c) chemical consumption | ☐ 74 | ☐ 75 |
| (d) operational control tests | ☐ 76 | ☐ 77 |
| (e) bacteriological examinations | ☐ 78 | ☐ 79 |
| (8) Cross-connection control | END CARD 5 S 80 | |
| (a) ordinance | ☐ 13 | ☐ 14 |
| (b) program implementation | ☐ 15 | ☐ 16 |
| (c) progress | ☐ 17 | ☐ 18 |

73<

## 9. SOURCE, TREATMENT & DISTRIBUTION, continued

B. During the past 3 years, raw water quality has ☐ 19 improved, ☐ 20 deteriorated, or ☐ 21 stayed the same.

## 10. PERSONNEL

A. Water Purification Operator

This is the responsible plant operator - Not sup't.

Get operator data for each supply even if there is no treatment.

(1) Highest level of formal education: ☐ 22 8th grade or less, ☐ 23 high school, ☐ 24 technical or trade school, ☐ 25 university.

(2) Level of training in water treatment: ☐ 26 college course, ☐ 27 technical or trade school, ☐ 28 short school, ☐ 29 on the job, ☐ 30 none, ☐ 31 other, specify ____________________.

(3) Length of time on this job: ☐☐ 32 33 years, ☐☐ 34 35 months.

(4) Number of previous positions as water treatment operator ☐☐ 36 37

(5) Total years of water purification experience ☐☐ 38 39

(6) Level of study in sanitary microbiology: ☐ 40 college course, ☐ 41 technical or trade school, ☐ 42 short school, ☐ 43 on the job, ☐ 44 none, ☐ 45 other, specify ____________________.

(7) Level of study in water chemistry: ☐ 46 college course, ☐ 47 technical or trade school, ☐ 48 short school, ☐ 49 on the job, ☐ 50 none, ☐ 51 other, specify. ____________________.

(8) Is the operator a full-time employee? ☐ 52 yes ☐ 53 no

(9) Salary range (per year) of operator: ☐ 54 <$1,999 ☐ 55 $2,000-4,999 ☐ 56 $5,000-7,499 ☐ 57 $7,500-9,999 ☐ 58 $10,000

PERSONNEL, continued

A. continued

(10) Is your present staff adequate in: Operator's opinion

(a) number ☐ 60 yes ☐ 61 no

(b) quality ☐ 62 yes ☐ 63 no

B. Operator's major complaint __________

C. Most frequent customer's complaint: Received by utility.

D. Management's most frequent complaint: __________

## 11. FINANCIAL INFORMATION

A. Bonded indebtedness: (water supply)

(1) General obligation bonds $ ☐☐☐☐☐☐☐☐ . 46 13 END CARD 6 ☐ 80

(a) statutory limit $ ☐☐☐☐☐☐☐☐ . 13 20

(2) Revenue bonds $ ☐☐☐☐☐☐☐☐ . 21 28

(a) statutory limit $ ☐☐☐☐☐☐☐☐ . 29 36

B. Capital stock, par value $ ☐☐☐☐☐☐☐☐ . 37 44

bonds, par value $ ☐☐☐☐☐☐☐☐ . 45 52

C. Water funds are ☐ 53 kept separate or ☐ 54 mingled with other funds.

D. Is there an annual payment to the general fund? ☐ 55 yes ☐ 56 no

E. Operation is controlled by: ☐ 57 mayor-council, ☐ 58 mayor-commission,

☐ 59 independent water board, ☐ 60 other, specify.________.

For city, district, etc. owned only

F. Is there active planning for expansion or improvement? ☐ 61 yes ☐ 62 no

(1) Value of planned improvement $ ☐☐☐☐☐☐☐☐ . 63 70

(2) Planning by utility ☐ 71 yes ☐ 72 no utility only

(3) Planning by consultants ☐ 73 yes ☐ 74 no utility & consultants

END CARD 7 ☐ 80

G. If expansion is planned, it will be carried out within:

| | 1 YR. | 2-5 YRS. | 6-10 YRS. |
|---|---|---|---|
| (1) Source | ☐ 13 | ☐ | ☐ 15 |
| (2) Treatment | ☐ 16 | ☐ | ☐ 18 |
| (3) Distribution | ☐ 19 | ☐ | ☐ 21 |
| (4) Other ____________ | ☐ 22 | ☐ | ☐ 24 |

H. Costs of production:

| | CENTS/1,000 GALLONS |
|---|---|
| (1) Chemicals | ☐☐.☐ 26 28 |
| (2) Labor, power, etc. | ☐☐.☐ 29 31 |
| (3) Depreciation | ☐☐.☐ 32 34 |
| (4) Other, including office, administration, meter reading, collection, etc. | ☐☐.☐ 35 37 |
| (5) Total | ☐☐.☐ 38 40 |

76<

11. FINANCIAL INFORMATION, continued

1. Tariff (Residential)

(1) Connection fee $ ☐☐☐☐. 41 44

(2) Sales unit is ☐ 45 per 1,000 gallons or ☐ 46 per 100 cu. ft.

(a) ☐☐☐ 47 cents for the first ☐☐ 50 51 units

(b) ☐☐☐ 52 cents for the next ☐☐ 55 56 units

(c) ☐☐☐ 57 cents for the next ☐☐ 60 61 units

(d) etc. as needed to cover steps.

Adjust all rates to these units.

END CARD 8 8 80

Note flat rate here as $/time unit

ECA-6 CIN,
1973

UNITED STATES PUBLIC HEALTH SERVICE
ENVIRONMENTAL CONTROL ADMINISTRATION
BUREAU OF WATER HYGIENE

SERIAL NO.
911

PUNCH IN COLS

## IDENTIFICATION OF WATER SAMPLE

1. LOCATION OF WATER SUPPLY Same as on inventory
CITY, COUNTY, STATE

FOR OFFICE USE ONLY ☐☐☐☐☐☐☐☐☐☐☐☐ 7 18

2. WATER SUPPLY NAME Same as on inventory

3. DATE OF SAMPLING — BEGINNING DATE OF COMPOSITE MO. DAY ☐☐☐☐ 19 22 — ENDING DATE OF COMPOSITE OR DATE OF GRAB SAMPLE MO. DAY YR. ☐☐☐☐☐☐ 23 28

4. SAMPLE FROM ☐ TREATMENT PLANT 8 ☐ WELL 4 ☐ RESERVOIR 2 ☐ DISTRIBUTION SYSTEM 1 ☐ OTHER 0 ☐

5. SAMPLING POINT LOCATION AND OR DESCRIPTION i.e. kitchen, 1234 Main ☐☐

6. TYPE OF WATER SAMPLED ☐ FINISHED 8 ☐ PARTIALLY TREATED 4 ☐ RAW 2 ☐ OTHER 0 ☐

7. SOURCE OF WATER ☐ SURFACE 8 ☐ GROUND 4 ☐ COMBINED 2 ☐ OTHER 0 ☐

8. SAMPLING METHOD ☐ COMPOSITE 8 ☐ GRAB 4 ☐ OTHER 0 ☐

9. ANALYSIS REQUIRED ☐ ORGANIC 8 ☐ TRACE ELEMENTS 4 ☐ WET 2 ☐ RADIO-CHEMICAL 1 ☐ OTHER 0 ☐

10. WATER SUPPLY CATEGORY ☐ COMMUNITY WATER SUPPLY 8 ☐ ICWS 4 ☐ FEDERAL INSTALLATION 2 ☐ SPECIAL STUDY 1 ☐ OTHER 0 ☐☐

11. APPEARANCE OF SAMPLE ____________

12. ADDITIONAL REMARKS ____________

13. COLLECTED BY ____________ ☐ ☐ OTHER ☐

DO NOT WRITE BELOW THIS LINE

LAB. SAMPLE NO. ____________ DATE RECEIVED ____________

LABORATORY REMARKS

OVER FOR INSTRUCTIONS

INSTRUCTIONS: EVERY ITEM OF INFORMATION REQUIRED FROM THE SAMPLER IS NUMBERED (1 THROUGH 13). THESE ARE THE ONLY RESPONSES THE SAMPLER SHOULD MAKE. NOTE AREAS MARKED ''DO NOT WRITE BELOW THIS LINE'' AND ''FOR OFFICE USE ONLY.''

ITEM 1 SHOULD BE THE LOCATION OF THE WATER SUPPLY FACILITY WHICH PRODUCED THE WATER FOR THE SAMPLE. (EXAMPLE: CINCINNATI, HAMILTON, OHIO.)

ITEM 2 SHOULD BE THE FULL NAME OF THE WATER SUPPLY FACILITY. (EXAMPLE: CINCINNATI MUNICIPAL WATER WORKS)

ITEMS 4, 6, 7, AND 8 - CHECK THE BOX WHICH APPLIES

ITEMS 9 AND 10 - CHECK ONE OR MORE BOXES AS NECESSARY

ITEMS 3, 5, 11, 12, AND 13 SHOULD BE SELF-EXPLANATORY

ANY RESPONSE OF ''OTHER'' OR ''SPECIAL STUDY'' SHOULD BE EXPLAINED UNDER ITEM 12 - ADDITIONAL REMARKS.

IF NECESSARY FOR COMPLETE IDENTIFICATION OR EXPLANATION, PLEASE FEEL FREE TO USE THE BACK OF THE ORIGINAL (WHITE) COPY OR ATTACH AN ADDITIONAL PAGE OF LIKE SIZE.

DISTRIBUTION:

MAIL ORIGINAL (WHITE COPY) TO:

WATER QUALITY REGISTER BRANCH
BUREAU OF WATER HYGIENE
222 E. CENTRAL PARKWAY
CINCINNATI, OHIO 45202

| | |
|---|---|
| BLUE | ENCLOSED WITH ORGANIC SAMPLE |
| PINK | ENCLOSED WITH TRACE METAL SAMPLE |
| YELLOW | ENCLOSED WITH WET CHEMISTRY SAMPLE |
| GREEN | ENCLOSED WITH RADIOCHEMICAL SAMPLE |
| TAN | RETAINED BY REGIONAL OFFICE OR SAMPLER |

ECA-9 (CIN)
(1-69)

UNITED STATES PUBLIC HEALTH SERVICE
ENVIRONMENTAL CONTROL ADMINISTRATION
BUREAU OF WATER HYGIENE
IDENTIFICATION OF WATER SAMPLE

SERIAL NO. 9111

PUNCH IN COLS. 1 6

1. LOCATION OF WATER SUPPLY ____________________
CITY, COUNTY, STATE

FOR OFFICE USE ONLY ☐☐☐☐☐☐☐☐☐☐☐☐ 7 18

DO NOT WRITE BELO THIS LINE

2. WATER SUPPLY NAME ____________________

3. DATE OF SAMPLING

BEGINNING DATE OF COMPOSITE: MO. DAY ☐☐☐☐ 19 22

ENDING DATE OF COMPOSITE OR DATE OF GRAB SAMPLE: MO. DAY YR. ☐☐☐☐☐☐ 23 28

4. SAMPLE FROM ☐ TREATMENT PLANT 8 ☐ WELL 4 ☐ RESERVOIR 2 ☐ DISTRIBUTION SYSTEM 1 ☐ OTHER 0 — ☐ 29

5. SAMPLING POINT LOCATION AND/OR DESCRIPTION ____________________ — ☐☐☐ 30 32

6. TYPE OF WATER SAMPLED ☐ FINISHED 8 ☐ PARTIALLY TREATED 4 ☐ RAW 2 ☐ OTHER 0 — ☐ 33

7. SOURCE OF WATER ☐ SURFACE 8 ☐ GROUND 4 ☐ COMBINED 2 ☐ OTHER 0 — ☐ 34

8. SAMPLING METHOD ☐ COMPOSITE 8 ☐ GRAB 4 ☐ OTHER 0 — ☐ 35

9. ANALYSIS REQUIRED ☐ ORGANIC 8 ☐ TRACE ELEMENTS 4 ☐ WET 2 ☐ RADIO-CHEMICAL 1 ☐ OTHER 0 — ☐ 36

10. WATER SUPPLY CATEGORY ☐ COMMUNITY WATER SUPPLY 8 ☐ ICWS 4 ☐ FEDERAL INSTALLATION 2 ☐ SPECIAL STUDY 1 ☐ OTHER 0 — ☐☐☐ 37 39

11. APPEARANCE OF SAMPLE ____________________

12. ADDITIONAL REMARKS ____________________

13. COLLECTED BY ____________________ ☐ USPHS STAFF ☐ OTHER — 1 80

DO NOT WRITE BELOW THIS LINE

LAB. SAMPLE NO. ____________________ DATE RECEIVED ____________________

LABORATORY REMARKS

# APPENDIX IV

## LABORATORY SURVEY REPORTS

# Report of a Survey of the
# Vermont State Public Health
# Water Laboratory

115 Colchester Ave.
Burlington, Vermont 05402
July 9-10, 1969
by

Edwin E. Geldreich, Research Microbiologist
Bureau of Water Hygiene
Public Health Service
Cincinnati, Ohio 45213

The equipment and procedures employed in the bacteriological analysis of water by the laboratory conformed with the provisions of "Standard Methods for the Examination of Water and Wastewater" (12th edition, 1965) and with the provisions of the Interstate Quarantine Drinking Water Standards, except for items marked with a cross "x" on the accompanying form PHS 875 (Rev. 1-66). Items marked with a "U" could not be determined at the time of the survey. Items marked "0" do not apply to the procedures programmed in the laboratory. Specific deviations are described with appropriate remedial action for compliance in the following recommendations:

## Recommendations

### 1. Sampling

Sample points should be located throughout the distribution system, including representative dead-end mains, to establish adequate bacteriological quality and to demonstrate that no contamination occurs through breaks in the distribution system (Standard Methods, page 570).

Although an adequate number of samples were collected for bacteriological analysis from Rutland, Vermont, during January of this year, 26 of the 31 samples were from the Mead Building with only two other locations chosen for the remaining 5 samples (see Table 1). Since this municipal supply was chosen at random, it is recommended that the sampling program of other public supplies be reviewed for their adequacy in monitoring the water quality, as delivered through the distribution systems.

Table 1.

## A Study Sample Transit Time, Frequency and Distribution

| Public Water Supply | Transit Time (Days) | Collection Date | Location | Coliforms/ 100 ml. |
|---|---|---|---|---|
| Rutland, Vt.<br>(Pop. 18,325) | 1 | 12/30/68 | Mead Bldg. | <1 |
| | 2 | 12/31/68 | 105 Center St. | 3 |
| | 1 | 12/31/68 | Mead. Bldg. | <1 |
| | 1 | 1/ 2/69 | Mead Bldg. | <1 |
| | 1 | 1/ 3/69 | Mead Bldg. | 1 |
| | 2 | 1/ 4/69 | Mead Bldg. | <1 |
| | 2 | 1/ 5/69 | 105 Center St. | <1 |
| | 1 | 1/ 6/69 | Mead Bldg. | <1 |
| | 1 | 1/ 7/69 | Mead Bldg. | <1 |
| | 1 | 1/ 8/69 | Mead Bldg. | <1 |
| | 1 | 1/ 9/69 | Mead Bldg. | <1 |
| | 1 | 1/10/69 | Mead Bldg. | <1 |
| | 2 | 1/11/69 | Mead Bldg. | <1 |
| | 2 | 1/12/69 | Mead Bldg. | <1 |
| | 1 | 1/13/69 | Mead Bldg. | <1 |
| | 1 | 1/14/69 | Mead Bldg. | <1 |
| | 2 | 1/15/69 | Mead Bldg. | <1 |
| | 1 | 1/16/69 | Mead Bldg. | <1 |
| | 1 | 1/17/69 | Mead Bldg. | <1 |
| | 2 | 1/18/69 | Mead Bldg. | <1 |
| | 2 | 1/19/69 | 105 Center St. | <1 |
| | 1 | 1/20/69 | Mead Bldg. | <1 |
| | 1 | 1/21/69 | Mead Bldg. | <1 |
| | 1 | 1/22/69 | Mead Bldg. | <1 |
| | 1 | 1/23/69 | Mead Bldg. | <1 |
| | 1 | 1/24/69 | Mead Bldg. | <1 |
| | 2 | 1/25/69 | Mead Bldg. | <1 |
| | 2 | 1/26/69 | 105 Center St. | <1 |
| | 1 | 1/27/69 | Mead Bldg. | <1 |
| | 1 | 1/27/69 | Howard Johnson Motel | <1 |
| | 1 | 1/28/69 | Mead Bldg. | <1 |
| | 2 | 1/29/69 | 105 Center St. | <1 |
| | 1 | 1/30/69 | Mead Bldg. | <1 |
| | 1 | 1/31/69 | Mead Bldg. | <1 |
| Essex Junction, Vt.<br>(Pop. 8,399) | 7 | 4/ 1/69 | Shopping Center,<br>2 Pearl Street | <1 |
| | 7 | 4/ 1/69 | 2 Pearl Street | <1 |
| | 1 | 4/ 7/69 | 2 Pearl Street | <1 |
| | 1 | 4/ 7/69 | 2 Pearl Street | <1 |

Table 1. (Cont'd)

| Public Water Supply | Transit Time (Days) | Collection Date | Location | Coliforms/ 100 ml. |
|---|---|---|---|---|
| Essex Junction, Vt. (Cont'd) | 3 | 4/ 8/69 | Bldg. 325 | <1 |
| | 3 | 4/ 8/69 | 2 Pearl St. | <1 |
| | 3 | 4/ 8/69 | 2 Pearl St. | <1 |
| | 3 | 4/ 8/69 | 2 Pearl St. | <1 |
| | 4 | 4/11/69 | 2 Pearl St. | <1 |
| | 1 | 4/14/69 | 2 Pearl St. | <1 |
| | 1 | 4/14/69 | 2 Pearl St. | <1 |
| | 1 | 4/14/69 | 2 Pearl St. | <1 |
| | 1 | 4/14/69 | 2 Pearl St. | <1 |
| | 3 | 4/15/69 | 2 Pearl St. | <1 |
| | 3 | 4/15/69 | 2 Pearl St. | <1 |
| | 2 | 4/16/69 | 2 Pearl St. | <1 |
| | 7 | 4/17/69 | 2 Pearl St. | --- * |
| | 6 | 4/18/69 | 2 Pearl St. | --- * |
| | 3 | 4/21/69 | Shopping Center Laundromat | --- * |
| | 3 | 4/21/69 | Lincoln Hall | --- * |
| | 3 | 4/21/69 | Pleasant St. | --- * |
| | 2 | 4/22/69 | 2 Pearl St. | <1 |
| | 2 | 4/22/69 | Fort Pump House | <1 |
| | 1 | 4/23/69 | 2 Pearl St. | <1 |
| | 1 | 4/23/69 | 2 Pearl St. | <1 |
| | 1 | 4/24/69 | 2 Pearl St. | <1 |
| | 5 | 4/25/69 | 2 Pearl St. | <1 |
| | 5 | 4/25/69 | 2 Pearl St. | <1 |
| | 2 | 4/28/69 | Lincoln Hall | <1 |
| | 2 | 4/28/69 | 23 Pleasant St. | 5 |
| | 2 | 4/28/69 | 2 Pearl St. | <1 |
| | 3 | 4/29/69 | Bldg. 325 | <1 |
| | 3 | 4/29/69 | 2 Pearl St. | <1 |
| | 8 | 4/30/69 | Shopping Center Laundromat | --- * |
| | 4 | 5/ 4/69 | Shopping Center Laundromat | --- * |
| | 4 | 5/ 5/69 | Lincoln Hall | --- * |
| | 2 | 5/13/69 | Pump House | <1 |
| | 2 | 5/13/69 | 2 Pearl St. | >100 |
| | 2 | 5/13/69 | Lincoln Hall | <1 |
| | <1 | 5/13/69 | Shopping Center Laundromat | 15 |

Table 1. (Cont'd)

| Public Water Supply | Transit Time (Days) | Collection Date | Location | Coliforms/ 100 ml. |
|---|---|---|---|---|
| Essex Junction, Vt. (Cont'd) | <1 | 5/13/69 | Pleasant St. | <1 |
| | <1 | 5/13/69 | Lincoln Hall | <1 |
| | 3 | 5/14/69 | Shopping Center Laundromat | >100 |
| | 2 | 5/15/69 | 2 Pearl St. | <1 |
| | 1 | 5/16/69 | Lincoln Hall | <1 |
| | 1 | 5/16/69 | Lincoln Hall | <1 |
| | 3 | 5/19/69 | 2 Pearl St. | <1 |
| | 3 | 5/19/69 | 23 Pleasant St. | >100 |
| | 7 | 5/20/69 | Bldg. 325 | --- * |
| | 7 | 5/20/69 | Shopping Center Laundromat | --- * |
| | 6 | 5/21/69 | Shopping Center Laundromat | --- * |
| | 6 | 5/21/69 | 2 Pearl St. | --- * |
| | <1 | 5/23/69 | 2 Pearl St. | 14 |
| | <1 | 5/23/69 | Shopping Center Laundromat | 2 |
| | 1 | 5/26/69 | Shopping Center Laundromat | <1 |
| | 1 | 5/26/69 | Lincoln Hall | <1 |
| | 1 | 5/26/69 | 23 Pleasant St. | <1 |

---

* Sample rejected by laboratory, too old.

## 4. Sample transportation and storage

A random examination of laboratory records (Table 1) for two large cities, Rutland (Population 18,325) and Essex Junction (Population 8,399) reveal sharp contrasts in sample transit time. During the period December 30 - July 31, 1969, all 34 samples from Rutland, Vermont (distance of 69 miles) were received within 48 hours. However, during a period April 1 - May 26, 1969, only 33 of a total 61 samples taken in Essex Junction, Vermont (distance of 6 miles) were received within a 48-hour period. The remaining samples required from 3 to 8 days transit time.

The laboratory rejected only 11 of this old samples from Essex Junction. The validity of data that might be obtained in processing old samples is highly questionable since the bacterial density will not remain static. In the presence of suitable nutrients and water temperature above 15°C, bacterial multiplication will occur. In the absence of nutrients or in contact with toxic metal ions, the bacterial death rate will be accelerated. In either case, an unpredictable change occurs.

Every effort must be made to impress sample collectors to time their mail shipments with optimum transportation schedule. Sample collectors should avoid sampling on Thursday, Friday and any work day prior to holidays when sample delivery to the laboratory is through U. S. mail service. Sample collections delivered by car should be scheduled to reach the laboratory promptly and not be postponed to some more convenient time during the next few days.

## 5. Remedial action for unsatisfactory samples

After a single unsatisfactory sample is examined, it is necessary to examine additional samples from the same point at daily intervals until two consecutive negative samples are secured (Standard Methods, page 570). Such special samples should not be included in totaling the number of samples routinely examined monthly as required by U.S. Public Health Service Standards for Drinking Water Quality. Random data examined from Essex Junction (Table 1) illustrates the lack of successive sampling to get two consecutive negative results from the laundromat at the shopping center.

## 8. Standard Thermometer

This laboratory should purchase a thermometer certified by the National Bureau of Standards for use in verifying the accuracy of all therometers routinely used to monitor temperatures in incubators, water baths, hot-air sterilizing ovens, and autoclaves. Occasional breakage of thermometers normally occurs in every laboratory and necessitates replacement with new units. Temperature is a critical factor that must be accurately measured and controlled in many laboratory procedures.

Replacement thermometers should be verified as to their accuracy at selected temperatures within the minimum and maximum range of intended use, by comparison to parallel readings obtained from the certified thermometer. All "in-use" thermometers should be rechecked periodically for development of hair-line breaks in mercury columns which will result in a loss of measuring accuracy. These air space separations can be eliminated by carefully controlled submersions in alternate high and low temperature water baths, taking care that the maximum temperature does not exceed the range of thermometer.

## 9. Incubator

An inspection of the daily record of incubator temperatures for the period from January 17-July 9, 1969, shows a progressive decrease in temperature from 34.5° to 33.5°C. No attempt has been made to correct the incubator temperature to the recommended 35°C through proper thermostat adjustment. The purpose of maintaining a record of incubator temperature is intended to alert the laboratory personnel to any gradual changes that may reflect decreased stiffness of a new bi-metallic element of the incubator thermostat. The theromemeter bulb should be continuously immersed in liquid (glycerine, water, or mineral oil) to buffer any effect from room temperature influences when the incubator door is opened for inspection.

The accidental reduction in incubation temperature below 35°C will increase the problems of interference and false positives associated with non-coliform organisms common to well waters, lakes and some small streams. On the membrane filter, *Paracolobactrum* species occur as the most frequent false positive, producing sheen reaction as a result of the partial breakdown of lactose. In general, we find these organisms grow better at temperatures below 35°C. False positive results in the multiple tube confirmed test may originate from several sources including anaerobic spore formers of the *Clostridium welchii* type, spore-bearing aerobic forms related to *Bacillus subtiles* and to the symbiotic action of two different organisms neither of which alone can ferment lactose. Any further decrease in incubation temperature below 35° ± 0.1°C will change the spectrum of organisms in the indicator system and decrease the specificance of the total coliform test in terms of sanitary significance.

## 26. Distilled water

Distilled water for microbiological use should be free of inorganic and organic substances, either toxic or nutritive that could influence survival or growth of bacteria and viruses. Many factors can influence the quality of a laboratory water supply: (1) design of the distillation apparatus;(2) source of raw water; (3) residual build-up in the distillation system; (4) condition of the deionizing column, if used; (5) use and abuse of a carbon filter; (6) storage chamber for reserve supply; and (7) temperature of stored supply and duration of storage before use. These factors may contribute varying degrees of contamination such as metal ions from the distillation system; ammonium hydroxide, hydrochloric acid, and other fumes from the laboratory; chlorine from the tap water supply; and $CO_2$ from the air.

With the installation of a new automatic glassware dishwasher (Better Built, Turbomatic) demand on the distilled water supply for glassware rinse water plus use in various laboratory procedures has necessitated the purchase of a supplemental glass still for exclusive use in preparing laboratory reagents and media. Inspection of the Corning all-glass still shows the need for a more frequent still "clean-up" to reduce chemical residual accumulation. The Barnstead still, used to supply the automatic dishwasher, has not been evaluated within the last two years for production of distilled water suitable for biological use. The Corning all-glass still is heavily coated with chemical residue accumulated during the last six months. A shut-down for still maintenance apparently is difficult to schedule since there is no storage tank available to hold a reserve supply of distilled water. Currently both stills are being used to maximum capacity, there is no storage tank available for output from the glass still and the older still operates only during the working hours since the steam supply is shut-off each night. A third still is available and should be reconditioned to be used in standby during periods when the other stills must be cleaned and serviced. A supply tank should be purchased for use in storing water produced by the glass still or the recommended standby unit. The laboratory director should assign one of the staff members to be responsible for distilled water quality, adequate production, and maintenance.

The recommended distilled water suitability test can be used to evaluate newly installed water distillation apparatus, repaired distilled water systems, and as a periodic check of existing stills, storage tanks and distribution systems for contamination build-up. It is recommended that this procedure should be used once each year to check the water quality and at other times following line alterations and repairs.

## 55. Filtration

After all of the water sample has passed through the membrane filter, the sides of the funnel walls should be rinsed down with at least 20 ml of sterile dilution water (Standard Methods, Page 614, Section 5.2). The flushing procedure should be repeated after all of the first rinse has passed through the filter. The purpose of the funnel rinse is to flush all droplets of a sample from the funnel walls to the membrane filter. This will insure collecting essentially all of the sample bacterial flora on the membrane surface for coliform examination.

## 61. Recommended laboratory practices

Since the bacteriological procedures used to examine potable water are those described in the current edition of "Standard Methods for the Examination of Water and Wastewater" (12th edition, 1965) it is essential that a copy of this book be purchased and assigned to the microbiological section. The only available copy of the current edition of Standard Methods is assigned to the chemistry section. Separate copies should be made available to water chemistry and bacteriology. The next edition of this reference is tentatively scheduled for publication in late 1970.

## Remarks

### 1. Ultra-violet sterilization

Although the current boiling water procedure for sterilizing glass filter funnels between successive potable samples is adequate, the use of ultra-violet light sterilization is recommended. This latter procedure is faster to perform without the hazards of accidental splash of boiling water over the technician's hands and eliminates humidity build-up from flowing steam vapors escaping into the small laboratory room. A suitable ultra-violet sterilizer cabinet can be built for approximately $50.00. Further advice and possible short-term loan of such a unit for a trial period can be arranged through:

Dr. Chester Rhines
National Technical Investigations Branch
Federal Water Pollution Control Administration
Ohio Basin Region
4676 Columbia Parkway
Cincinnati, Ohio 45226

### 2. Colony counting procedure and light source

Membrane filter colonies are best counted in the moist condition associated with their growth, using a magnification of 10-15 diameters and a cool, white fluorescent light source adjusted to an angle of 60°-80° above the coliform colonies. This light source adjustment is particularly critical to get optimum reflection of the golden metallic luster from such colonies on Endo-type medium. The use of incandescent light is not adequate for colony sheen observation.

For many years, the staff of the Vermont State Health laboratory have practiced a procedure in which the membrane filter colonies are removed from the culture dish, placed on kraft paper to dry, then counted under 10-15 diameter magnification using an incandescent light source. Repeated comparison of their non-standard procedure with that recommended by Standard Methods indicates their counts are reliable. However, this counting procedure is more time consuming then necessary and is open to question whenever dried colonies are to be subjected to verification in brilliant green broth. They have estimated that 90% of all verifications are capable of growth from these dried colonies. Attenuated colonies and those subjected to more than a few minutes of drying may not necessarily be capable of growth in the selective brilliant green broth. Therefore, it is recommended that the current practice of counting dried coliform colonies be discontinued because it is time consuming and may not yield verification on all coliform colonies that might be challenged through broth inoculation.

### 3. Laboratory sink

At the present time, the water microbiology laboratory does not have a sink for draining waste waters either from media preparations or sample filtrates. A drain pipe is available in this small laboratory, but a sink basin and water connections has not as yet been installed, partly because minimum available space near the incubator and refrigerator. The installation of a small sink drain with water supply connections will save time in waste water disposal now carried to sinks in other rooms.

## State Water Laboratory Evaluation Program

The Vermont State Health Department Laboratory currently examines all municipal water samples and most of the private water samples. There are also some undetermined number of private supplies examined by the Vermont State Department of Agricultural Laboratory in Montpelier, Vermont. Personnel of one city hospital laboratory received training in bacteriological examination of water samples by the membrane filter procedure from staff members of the State laboratory. However, it is not known at this time if this hospital is examining any water samples. There are no known private laboratories within Vermont that will perform a bacteriological examination of water.

At such time when some municipal, hospital or private laboratory begins to accept water samples for bacteriological examination, a State Laboratory Approval Program should be initiated and a State Water Laboratory Survey Officer appointed who will be able to evaluate procedures in these laboratories.

## Commendation

In many laboratories, the weakest link in the system frequently reverts back to poor quality work being performed in the preparation and sterilization section. Since the salaries are generally lower, personnel turn-over for this type of duty is frequent and these positions attract employees who often have little personal pride in their work or understanding of the importance of their part of the laboratory service.

For these reasons, the Vermont State Health Laboratory personnel assigned to preparation of clean glassware, sterilization requirements, and careful preparation of media are to be commended for their conscientious efforts in supplying these essential services on a quality basis.

## Personnel Approved

The following personnel are approved for the application of the total coliform membrane filter procedure to the bacteriological examination of potable water:

Mr. Terry Macaig, Chief Microbiologist
Mrs. Lucinda Linney, Laboratory Technician

## Conclusions

The procedures and equipment in use at the time of the survey complied in general with the provisions of Standard Methods for the Examination of Water and Wastewater (12th edition, 1965) and the Public Health Service Drinking Water Standards and with correction of deviations listed, it is recommended that the results be accepted for the bacteriological examination of water under interstate regulations.

Edwin E. Geldreich
Consulting Microbiologist

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE

PHS-875
(Rev. 1-66)

# Survey Form for Water Laboratories (Bacteriological)

*Indicating conformity with Public Health Service Drinking Water Standards*

SURVEY BY Edwin E. Geldreich

X=DEVIATION U=UNDETERMINED 0=NOT USED

LABORATORY Vermont State Public Health

LOCATION 115 Colchester Avenue
Burlington, Vermont 05402

DATE Jul 9-10, 1969

## SAMPLES

**1. Sampling**
Representative points throughout distribution system x
Location and frequency of sampling adequate
Minimum number monthly adequate for population
Repetitive samples from designated points as well as others to establish bacteriological quality throughout system
Proportionately more samples from small population areas

**2. Collection Procedure**
Volume necessary for all tests
Minimum sample not less than 100 ml
Ample air space shall be left in bottle to facilitate mixing
Representative sample collected without contamination
Tap sample collected from tap connected directly to main by service pipe
Do not collect sample from tap connected to storage tank
Tap allowed to waste water until service line has been cleared
River, stream, lake, or reservoir sample collected by plunging opened bottle with neck downward below surface
Collect with mouth end toward current (or away from hand)
Pump allowed to waste water 5 min before taking sample
Promptly identify sample legibly and indelibly
Complete and accurate data accompanies sample

**3. Dechlorination** 2 drops of 10% solution
Sodium thiosulfate used for dechlorination
Added before sterilization of bottle
Concentration approximately 100 mg/l

**4. Transportation and Storage**
Temperature maintained as close as possible to the water temperature at time of collection
Initiate examination as soon as possible after collection
Recommended time within 1 hr after collection 48
Time between collection and examination not exceeding ~~XX~~ hr x
Establish field procedure where time exceeds 24 hr
Time and temperature of storage recorded

**5. Remedial Action For Unsatisfactory Sample**
If three or more positive tubes per test, or
Four or more coliforms per 100 ml by membrane filter
Daily samples from point promptly examined until two consecutive samples are satisfactory x

**6. Record of Laboratory Examinations**
Results assembled and available for inspection
Consistent compliance with water quality standards
Laboratory methods and technical competence of local government, waterworks, and commercial laboratories approved by reporting agency

## LABORATORY APPARATUS

**7. Sample Bottles** 4 oz.
Glass resistant to solvent action of waters
Plastic sample bottles which may be sterilized and yield no toxic substances
Holds sufficient sample with air space for all necessary bacteriological tests, maintains sample uncontaminated
Closure:
a. Glass stopper covered, before sterilization, with metal foil, rubberized cloth, or heavy impermeable paper
b. Metal or plastic screw cap with leak-proof liner, provided both are free from toxic substances on sterilization

**8. Thermometer**
Accuracy checked with thermometer certified by National Bureau of Standards, or one of equivalent accuracy x

**9. Incubator** x
Maintain uniform temperature in all parts (±1.0° C)
Either water-jacket (filled) or anhydric type, with low-temperature, thermostatically controlled electric heating units properly insulated and located in or adjacent to walls or floor
Provided with shelves so spaced as to assure uniformity of temperature
Sufficient size (provide 1-in. space between walls, dishes, or baskets)
Accurate thermometer with bulb immersed in liquid on each shelf x
Daily record of temperature, or
Optionally use automatic devices of predetermined accuracy for recording temperatures
Unless recording thermometers are in continuous operation, preferably install maximal and minimal registering thermometer on middle shelf to record temperature variations over 24-hr period
At intervals determine temperature variations within incubator when filled to maximal capacity
Keep where temperatures do not vary excessively (50-80°F)

**10. Incubator Room** 0
Optionally use walk-in rooms, well insulated, equipped with properly distributed heating units and forced-air circulation
Provided areas conform to desired temperature limits
Record daily range in temperature in areas used for plates

**11. Hot-Air Sterilizing Oven** Freas, Model 845
Size sufficient to prevent crowding of interior
Constructed to give uniform and adequate sterilizing temperatures (check temperature variations within oven)
Equipped with thermometer registering accurately at 160-180° C
Recording thermometer (optional)

**12. Autoclaves** Castle
Size sufficient to prevent crowding of interior
Constructed to provide uniform temperatures up to and including 121° C
Equipped with accurate thermometer with bulb properly located to register minimal temperature within chamber

(Rev. 1-66)

### Laboratory Apparatus (continued)

Recording thermometer (optional)
Pressure gages and properly adjusted safety valve
Connected with saturated-steam line, or to gas or electrically heated steam generator
Reach sterilizing temperature in ~~30~~ 20 min
Small pressure cookers may be substituted only in emergencies and only where satisfactory results have been demonstrated
And provided pressure cooker has pressure gage and thermometer with bulb 1 in. above water level

**13. Colony Counter** 0
Quebec colony counter, dark-field model preferred
* Or one providing equivalent magnification and visibility

**14. pH Equipment** Beckman Zeromatic
Electrometric pH meter shall be used for pH of media

**15. Balances** Ohaus Balance
a. Balance with sensitivity of 2 g at 150-g load shall be used
Appropriate weights of good quality
b. Analytical balance with sensitivity of 1 mg at 10-g load
Appropriate analytical grade weights
Used for weighing quantities less than 2 g

**16. Media Preparation Utensils**
Borosilicate glass
Stainless steel
Other noncorrosive utensil
Clean and free from foreign residues or dried agar
Free from toxic or foreign materials which may contaminate media (such as detergents, chlorine, copper, zinc, antimony, or chromium)

**17. Pipets**
Deliver accurately and quickly
Calibration error not exceeding 2.5%
Tips unbroken, graduation distinctly marked
Mouth end plugged with cotton (optional)
Pipets conforming to APHA specifications (S. M. Exam. Dairy Prod. 11th ed.) may be used (optional)

**18. Pipet Containers**
Box, aluminum or stainless steel, 2-3 x 16 in.
Paper wrappings of good quality sulfite paper (optional)
Copper cans or boxes prohibited

**19. Dilution Bottles or Tubes**
Borosilicate or other noncorrosive glass
~~Glass stoppers or~~ rubber stoppers
Screw cap with leak-proof liner free from toxic substances on sterilization
*Cotton plugs prohibited
Graduation level indelibly marked on side of bottle or tube
Non-toxic plastic bottles may be substituted

**0. Petri Dishes**
Clear bottom, free from bubbles and scratches
Diameter 100 mm x 15 mm high (XXX XXXX for M.F.) 150 x 20 mm
Bottom flat for medium of uniform thickness
Glass or porous top
Presterilized plastic dishes proven free from toxic substances and sterile may be substituted for single use only

**1. Petri Dish Containers** 0
Used to protect and handle before and after sterilization
Aluminum or stainless steel (not copper) cans with covers, coarsely woven wire baskets or char-resistant paper sacks or wrappings

**22. Fermentation Tubes**
Sufficient size to conform with requirements for concentration of nutrient ingredients and sample as described subsequently

## PREPARATION

**23. Cleaning Glassware** Better Built Turbomatic
Thoroughly washed with suitable detergent and hot water (160° F) Equal Portions of HiTemp + Heikol
Rinsed in clean water at 180 °F to remove detergent
Rinsed with distilled water
Freedom from any residue on drying
Free from acidity or alkalinity
Detergent leaves no toxic residue

**24. Sterilization of Glassware**
Heat glassware not in metal containers for not less than 60 min at 170° C
Optionally use 160° C for 60 min with constant temperature recording device if oven temperatures are uniform
Heat glassware in metal containers for not less than 2 hr at 170° C
Non-plastic sample bottles as above, or
Autoclave at 121° C for 15 min
Plastic sample bottles that distort on autoclaving sterilized by low-temperature ethylene oxide gas

**25. Buffered Dilution Water**
Stock phosphate buffer solution at pH XX pH 7.3
Freshly prepared when stock solution shows trace of turbidity
Optionally autoclave stock buffer and store in refrigerator
1.25 ml of stock buffer added to 1 liter distilled water
Dispense to give 99± 2 ml or 9± 0.2 ml after autoclaving
Sterilized in autoclave at 121° C for 15 min
Quantity after sterilization with 2% or less deviation
Dilution volumes of 9 ml may be measured aseptically

## MEDIA — MATERIALS AND PROCEDURES

**26. Water** Barnstead and Corning All-Glass Still
Distilled or demineralized water used for media, reagents, blanks, etc.
Free from traces of dissolved metals or chlorine
Neutralize distilled water if free chlorine is present
Free from bactericidal compounds as measured by bacteriological suitability test using *Aerobacter aerogenes* ×

**27. Media Ingredients**
Beef extract
Yeast extract
Peptone
Sugars
Agar
Above preparations demonstrated to give satisfactory results for bacteriological purposes

**28. General Chemicals**
Reagent or ACS grade

**29. Dyes**
Certified by the Biological Stain Commission for use in media

**30. Storage**
Dehydrated media stored tightly in dark (low humidity) at less than 30° C
Not used if discolored or caked
Culture media stored in clean, dry space free from contamination and excessive evaporation

PHS-875
(Rev. 1-66)

# Survey Form for Water Laboratories (Bacteriological)

X=DEVIATION U=UNDETERMINED 0=NOT USED

| | | |
|---|---|---|
| LABORATORY<br>Vermont State Public Health | LOCATION 115 Colchester Avenue<br>Burlington, Vermont 05402 | DATE<br>Jul 9-10, 1969 |

### Media — Materials and Procedures (continued)

Batches used in less than 1 week
Protected from strong light
Fermentation tubes stored at room temperature not over 1 week..
Fermentation tubes stored at low temperatures must be incubated overnight and tubes with air bubbles discarded

**31. Adjustment of Reaction**
Expressed in concentration of hydrogen ions (pH)
Determine decrease in pH of individual medium in the autoclave used for its sterilization
Potentiometric method recommended for accurate determination..
Appropriate standard buffer used to calibrate pH meters pH7.0
Colorimetric method not used with media containing dyes
Indicator solution prepared to match color standards
Calibrated against standard buffer
Follow standard procedure, using a comparator

**32. Sterilization of Media**
All media, except sugar broths, autoclaved at 121° C for 15 min..
Timing starts when autoclave reaches 121° C temperature
Media removed and cooled as soon as possible after sterilization..
Tubes packed loosely in baskets for uniform heating and cooling....
Carbohydrate broths sterilized as above for 10 min
Optionally add sterilized carbohydrate solution aseptically to sterile media
Incubate tubes so prepared at 35° C for 24 hr before use
Total exposure of carbohydrate media to heat not over 30 min......

**33. Clarification** 0
Use filtration, sedimentation, or centrifugation as needed
Do not clarify with nutrient substances such as egg albumen

### CULTURE MEDIA — SPECIFICATIONS

**34. Per Cent Solutions**
Use grams of solute per 100 ml of solution

**35. Nutrient Broth** 0
Correct composition, sterility, and pH (6.8-7.0)

**36. Lactose Broth** 0
Correct composition, sterility, and pH (6.9±0.1)
Tubed in proper sized tube with inverted vial
Total time of exposure to any heat not more than 30 min
When quantities greater than 1 ml are planted, composition after planting will contain 0.013 g per ml of dry ingredients
Not less than 10 ml medium per tube
Dehydrated medium used. Brand .......... Lot No. ..........

**37. Lauryl Tryptose Broth** 0
Correct composition, sterility, and pH (6.8 ± 0.1)
Complies with general requirements described above
When quantities greater than 1 ml are planted, composition after planting will contain 0.0356 g per ml of dry ingredients..........
Dehydrated medium used. Brand .......... Lot No.

**Brilliant Green Lactose Bile Broth**
Correct composition. Brand BBL Lot No. 110634
Dehydrated ox gall only used in medium
Ox gall solution (10% in distilled water) has pH of 7.0 to 7.5....
Add 13.3 ml 0.1% solution brilliant green/l of medium

Sterile medium has pH of 7.1 to 7.4 (electrometric method only)

**39. Endo Medium** 0
Formula I used or
Formula II used
Correct composition, sterility, and pH (7.4 ± 0.1)
Proper reaction when seeded with coliforms
Dehydrated medium used. Brand .......... Lot No.

**40. Eosin Methylene Blue Agar** 0
Correct composition, sterility, and pH (7.1 ± 0.1)
Proper reaction when seeded with coliforms
Medium contains no sucrose. Catalog No.
Dehydrated medium used. Brand .......... Lot No.

**41. Tryptone Glucose Beef Extract Agar** 0
**Tryptone Glucose Yeast Extract Agar** 0
Correct composition, productivity, sterility, and pH (7.0 ± 0.1)
Sterile medium not remelted a second time after sterilization.
Free from precipitate
Dehydrated medium used. Brand .......... Lot No.

**42. M-Endo Medium**
Correct composition. Brand DIFCO Lot No. 518479
Prepare in clean presterilized borosilicate glassware
Reconstituted in distilled water containing 2% ethyl alcohol
Heated to boiling point (do not boil or submit to steam pressure)
pH between 7.1 and 7.3
Stored in dark at 2-10° C
Unused medium discarded after 96 hr

**43. M-Endo Agar Medium** 0
Correct composition. Brand .......... Lot No.
Reconstituted in distilled water containing 2% ethyl alcohol
Heated to boiling point (do not boil or submit to steam pressure)
pH between 7.1 and 7.3
Cool to 45-50° C and dispense 4 ml in 60-mm dishes
Keep plates in dark at 2-10° C (may store 2 weeks)

### TESTS FOR PRESENCE OF MEMBERS OF COLIFORM GROUP BY MULTIPLE-TUBE FERMENTATION TECHNIQUE

**44. Presumptive Test** 0
Lactose broth or
Lauryl tryptose broth
Before planting portions arrange tubes in order, number sample, or otherwise identify
Shake sample vigorously 25 times before removing portions
Inoculate fermentation tubes with appropriate quantities
Use 5 standard portions, either 10 or 100 ml
Concentration of ingredients conform to items 36 or 37
Quantities inoculated: 10 ml .......... 1 ml .......... 0.1 ml
Incubate tubes at 35 ± 0.5° C for 24 ± 2 hr
Examine for gas — any gas bubble positive
Return negative tubes to incubator
Examine for gas at 48 ± 3 hr from original incubation
Record presence or absence of gas at each examination
Gas in any quantity in 48 ± 3 hr is positive Presumptive Test
No gas in 48 ± 3 hr is negative test
94 Do not record gas produced after 51 hr of incubation

PHS-475
(Rev. 1-66)

## Tests for Presence of Members of Coliform Group by Multiple-tube Fermentation Technique (continued)

**45. Confirmed Test** 0

Promptly submit all presumptive tubes showing gas production before or at 24-hr and 48-hr periods to Confirmed Test

**a. Brilliant green lactose bile broth**

Gently shake tube or mix by rotating

Transfer one loopful of positive broth to brilliant green bile

Using sterile loop of 24-gage wire not less than 3 mm diameter

Incubate for 48 ± 3 hr at 35° ± 0.5° C

Formation of any gas in the inverted vial within 48 ± 3 hr constitutes a positive Confirmed Test

**b. Endo or eosin methylene blue agar plates**

Streak one or more plates with inoculum from positive primary fermentation tube(s)

Use innculating needle slightly curved at tip

Tap and incline tube to avoid any scum

Insert needle approximately 5 mm

Streak agar surface with curved section

To obtain discrete colonies separated by at least 0.5 cm

Incubate at 35° ± 0.5° C for 24 ± 2 hr

If typical nucleated colonies with or without sheen develop, the Confirmed Test is positive

If atypical, unnucleated pink colonies develop, result is doubtful and Completed Test must be applied

If no colonies or only colorless colonies without mucoid characteristics, the Confirmed Test is negative

**c. Alternate application** with multiple portions and dilutions

Optional only with three or more decimal dilutions

Submit to Confirmed Test all positive tubes of two highest dilutions (smallest volumes) occurring in 24 hr

Record any tube showing gas in 24 hr which has not been confirmed as positive Confirmed Test

Submit to confirmation all tubes negative at 24 hr and positive in 48 hr (no exception)

**46. Completed Test** 0

Applied to positive Confirmed Test fermentation tubes or

To doubtful appearing colonies on differential plate medium

If from liquid medium, streak as in item 45b

Fish one or more typical colonies to transfer to lactose or lauryl tryptose broth [illegible] and to an agar slant or

Fish two or more atypical colonies as described above

Choose colonies separated by 0.5 cm

Incubate at 35° ± 0.5° C for 24 ± 2 or 48 ± 3 hr

Examine agar slant with Gram-stain if corresponding secondary lactose broth showed gas in 24 or 48 hr

Gram-negative rods without spores and gas in lactose tube is positive Completed Test

Absence of gas in lactose tube in 48 hr — negative test

Only Gram-positive bacteria in stain — negative test

**47. Application of Tests to Routine Examination**

**a. Presumptive Test** applied to:

Samples not being considered for drinking water

Routine raw water quality where applicable in plant

**b. Confirmed Test** applied to:

Waters to which Presumptive Test is not applicable

Routine samples of drinking water, process or finished water

Chlorinated sewage effluents

Bathing waters

**c. Completed Test** applied to:

Examination of water samples where results are to be used for the control of the quality of raw or of finished waters

If not applied to all such samples, then applied to such a proportion as to establish beyond reasonable doubt the value of the Confirmed Test in determining their sanitary quality

**48. Number of Tests Per Year**

Presumptive Total + —

Confirmed Total + —

Completed Total + —

### TESTS FOR PRESENCE OF MEMBERS OF COLIFORM GROUP BY MEMBRANE FILTER TECHNIQUE

**49. Application As Standard Test**

Use as a standard test for determining potability of water after demonstration by parallel testing that it yields information equal to that from the multiple-tube fermentation procedure

Examine not less than 50-ml sample

**50. Laboratory Apparatus** (See items 7, 17-21)

Graduated cylinders accurate within 2.5% and

Openings covered with metal foil or substitute before sterilization

Use glass containers for culture medium

Filtration unit — any type that can be sterilized glass units

Filters all the sample through the membrane

Vacuum source (water trap to protect pump desirable)

Funnel and filter receptacle wrapped separately for sterilization and storage

**51. Filter Membranes** Millipore

Full bacterial retention, satisfactory speed of filtration

Stable in use, glycerin free, free from substances toxic to growth

Preferably grid marked, non-toxic ink

Adequately protected during sterilization from recontamination

Autoclaved at 121° C for 10 min (or presterilized)

**52. Absorbent Pads**

Filter paper free from growth inhibitory substances

Approximately 48 mm diameter

Thickness will permit absorbing 1.8 - 2.2 ml medium

Sterilized before using in test (121° C for 10 min)

**53. Forceps**

Round tipped, without corrugations

Membranes and pads handled with sterile (alcohol flamed) forceps

**54. Microscope and Lamp**

Preferably binocular wide field, 10 to 15 diameters magnification

Fluorescent light adjacent above perpendicular to filter plane

Other optical device giving equivalent results

**55. Filtration**

Suitably disinfect bench surface, allow to dry

Filter holding unit sterile at start of series

Use support for inverted funnel between samples (optional)

Place sterile membrane on porous plate, secure funnel

Apply vacuum, filter appropriate sample volume (number of tests uncountable not excessive) and rinse funnel

By filtering 3 volumes of 20-30 ml of sterile buffered water X

Remove filter with sterile forceps

**56. Standard Test — Single Step**

**a. Broth** — Sterile pad placed in culture dish

Saturated with M-Endo medium (42)

Allow to stand a few minutes before pouring off excess

Prepared filter (55) rolled (grid side up) onto pad

**b. Agar** — Use culture dish previously prepared (43)

Prepared filter (55) placed on agar with rolling motion

PHS-875
(Rev. 1-66)

# Survey Form for Water Laboratories (Bacteriological)

X=DEVIATION U=UNDETERMINED 0=NOT USED

ORATORY
Vermont State Public Health

LOCATION 115 Colchester Avenue
Burlington, Vermont 05402

DATE
Jul 9-10, 1969

### Tests for Presence of Members of Coliform Group by Membrane Filter Technique (continued)

**57. Standard Test — with Enrichment** 0
Sterile pad placed in culture dish
Saturated with approximately 1.8 ml enrichment medium (37)
Carefully remove any excess liquid
Prepared filter (55) placed on pad
Incubate inverted filter at 35° ± 0.5° C for 1½-2 hr
Remove dish from incubator and remove top
**a. Broth** — With sterile forceps lift pad and filter to top of dish
Place new sterile pad on bottom and saturate with medium (42)
Transfer filter to new pad (and discard used pad)
**b. Agar** — With sterile forceps strip filter from pad
Roll onto surface of previously prepared agar (43)
Optionally leave used pad in dish to maintain humidity

**58. Incubation**
In saturated humidity, with dish inverted
At 35° ± 0.5° C, for 22-24 hr
Incubate enriched tests for 20-22 hr

**59. Counting** Colonies dried prior to counting
Count all dark colonies with sheen as coliform colonies
If only atypical forms, establish identity
Calculation of direct count in density per 100 ml

**60. Number of Tests Per Year** Public,private,swimming po
Membrane Filter Total 11,357 + —

### MISCELLANEOUS

**61. Recommended Laboratory Practices**
Personnel adequately trained or supervised
Copy of Standard Methods (12th ed.) available in laboratory X
Level table or bench, ample working surface
In clean, well-lighted, well-ventilated room, reasonably free from dust and drafts
Floors clean, walls and ceilings smooth
Doors and windows screened, or insects and rodents absent
Space adequate, free from confusion
Used for laboratory purposes only
Table space, storage, and utilities adequate
Cabinets, shelves, and equipment neat, clean, and orderly
Clean outer garments worn
Clothing stored outside laboratory or in closet
Safety precautions and practices satisfactory

## SUPPLEMENTARY BACTERIOLOGICAL METHODS

**Applicable to non-potable surface, process and bathing waters, effluents, sea water, and shellfish.**

### STANDARD PLATE COUNT

**62. Sample Agitation** 0
Shaken vigorously 25 times immediately before removing portion
Each dilution shaken 25 times

**63. Plating**
Appropriate quantity of sample per plate
In highly polluted waters use dilutions in sterile dilution water
Plate not more than 1 or less than 0.1 ml (sample or dilution)
Add to each dish 10 ml or more liquefied agar medium
At temperature of 43-45° C
Melted medium stored for no more than 3 hr, 43-45° C
Gently lift cover of petri dish only high enough to pour medium
Agar and test portions thoroughly mixed, by rotating and tilting without splashing, and mixture spread evenly
Allow to solidify within 5-10 min on level surface
Invert (unless clay tops are used) and promptly incubate
Not more than 20 min between measuring sample and pouring

**64. Incubation**
Arrange so each plate or pile is separated by at least 1 in. from adjacent piles, and from top and walls of chamber
Incubate at 35° ± 0.5° C for 24 ± 2 hr, or
At 20° ± 0.5° C for 48 ± 3 hr
Any deviation stated in report
or shellfish incubate 48 ± 3 hr at 35° C

**65. Counting**
Record count observed on 1 ml sample with less than 30 colonies
Otherwise count only plates with between 30 and 300 colonies
Count colonies with approved counting aids
Record only two significant figures
Raise second digit from left by 1 when third digit is 5 or more
Record as "standard plate count at 35° C (or 20° C)"

### DIFFERENTIAL PROCEDURES

**66. Elevated Temperature Tests** 0
Applied to positive presumptive or coliform colony
Inoculate fermentation tube of EC medium (3 mm loop)
Placed in water bath within 30 min
Hold at 44.5° ± 0.5° C for 24 hr
Gas production is positive test (indicating fecal origin)
Absence of gas is negative reaction (non-fecal origin)
Used only as confirmatory test

**67. Differential Tests (Tentative)**
**a. Indole tests**
Tryptophane Broth (35° C, 24 ± 2 hr)
Satisfactory reagent (pH < 6.0)
Procedure satisfactory
**b. Methyl red test**
Buffered glucose broth (35° C, 5 days)
Satisfactory indicator
Procedure satisfactory
**c. Voges-Proskauer test**
Buffered or salt peptone glucose broth (35° C, 48 hr)
α-napthol solution fresh daily
Procedure satisfactory
**d. Sodium citrate test**
Koser's citrate broth (35° C, 3-4 days) or
Simmon's citrate agar (35° C, 48 hr)
Procedure satisfactory

# Report of a Survey of the
# Vermont State Department of Health
# Water Chemistry Laboratory

115 Colchester Avenue
Burlington, Vermont 05402

by

Earl F. McFarren, Chief
Analytical Reference Service
Bureau of Water Hygiene

In the company of Edwin Geldreich, Research Microbiologist, Bureau of Water Hygiene, the State Health Department Laboratories were visited on July 9th and 10th, 1969. Although in some areas our evaluations overlapped, for the most part the chemical and bacteriological surveys were conducted independently. Before leaving, however, we jointly reviewed our findings with both the Director, Bureau of Laboratories and the Chief, Bureau of Environmental Sanitation. Mr. Floyd Taylor, Water Hygiene Representative, Region II was present during our discussions with the latter.

## Personnel:

Mr. Harold Stowe is the Chief Chemist and chemist responsible for water analysis. In addition to water analysis the chemistry laboratory is responsible for routine glucose and cholesterol determinations for the Chronic Illness Control Program, for blood alcohol determinations for the state police and toxicology in general for the State Medical Examiner. In the latter efforts Mr. Stowe is assisted by Ted Manazir (pre-med. A. B. graduate) and Mrs. Mary Ellen Skelly (A. B. in chemistry).

Mr. Stowe appears to be well qualified for the job and in fact has done some original research in developing and modifying methods so that they can be done by auto-analyzer. He has automated methods for the determination of fluorides, nitrates, chlorides, glucose and cholesterol. It appears that he is underpaid, however, for if he were willing to move to Cincinnati I believe he could demand and get about a $6000 increase in salary working for the federal government. Granted, the cost of living here may be higher, but it does not seem that there could be that much difference.

## Equipment:

The laboratories (two, roughly 10 by 25 ft.) are well-equipped. They have a Bausch and Lomb Spectronic 20, a B & L 600 visible and ultra-violet recording spectrophotometer, a Beckman IR-20 infra-red spectrophotometer, a three channel auto-analyzer (Technicon), a Jarrel-Ash gas chromatograph with flame, thermo-ionic, and electron capture detectors, a Beckman pH meter, an all glass still, and a centrifuge.

## Water chemistry:

There are 240 municipal water supplies in the state and none of these have been routinely analyzed for the presence or absence of hazardous chemicals since 1962. About 200 water samples, for a total of 700 to 850 tests are carried out each month, but about two-thirds of these are just for fluoride. In fact, fluoride is the only routine test on water being carried out. The latter, of course, are only on those municipal supplies being fluoridated (currently about 17). The rest of the chemical determinations are largely for such things as calcium, sodium, chlorides, nitrates, hardness and iron on private (mostly drilled) wells. I was told that the Department of Health is required by law to analyze private water supplies. It would seem that an effort should be made to get this law changed so that the effort can be put where it affects the most people. A few municipal water supplies may be analyzed each year if and when someone thinks they have a problem. There are no private laboratories doing water chemistry and none of the municipal systems have any laboratories doing chemical analysis.

No pesticide analysis is done, and, in general, the same thing can be said for surfactants, sulfates, cyanide, zinc, cadmium, silver, barium, arsenic, and selenium. A few samples were analyzed for chromium.

## Fluoridation:

Analysis of waters for fluoride is being carried out at the request of the State Dental Health Office. This program is obviously needed for any control of the fluoridation is strictly dependent upon analysis by the state laboratory. This control appears rather poor, however, as indicated by the following data taken from the State Health Department records for the City of Barre, Vermont.

| Date | Fluoride, mg/l | Date | Fluoride, mg/l |
|---|---|---|---|
| 2-25 | 0.2 | 3-18 | 0.2 |
| 2-28 | 0.6 | 3-19 | 0.2 |
| 3-7 | 0.1 | 3-20 | 0.2 |
| 3-11 | 0.6 | 3-25 | 0.1 |
| 3-12 | 0.2 | 3-26 | 0.1 |
| 3-13 | 0.2 | 3-27 | 0.1 |
| 3-14 | 0.2 | | |

I was told that the low fluoride results were due to difficulties in the preparation of the appropriate fluoride feed stock. It doesn't seem that it would take a couple of months to correct this situation. However, it is encouraging to note that they apparently realize they have a problem, as a conference on fluorides was in progress on the day we arrived. Perhaps, it is only a matter of educating the operators to the fact that inadequate fluoridation is no better than none. I suspect, however, that they fear over-fluoridation and until they have developed some confidence in their ability to control the fluoride level, they will tend to be on the low side.

## Distilled water:

Between one and two years ago an automatic dishwasher was installed in the microbiology clean-up area. This washer requires large quantities of distilled water and because of insufficient storage facilities there is at times a shortage of distilled water. The still is a Barnstead of 15 gallons per hour capacity. To fill the gap the chemistry laboratory has a Corning all-glass still which is used to obtain water for preparation of all reagents. This is not entirely satisfactory either, however, as was evident by the fact that it had not been cleaned recently because the demand was so great it could not be shut down for cleaning. They did not have a conductivity meter or any other means for checking the quality of the distilled water and apparently no one routinely checked the condition of the large still.

## Other:

They did not have a National Bureau of Standards Thermometer for use in checking their incubator and water bath thermometers. Only one copy of "Standard Methods" was available to both the Bacteriology and Chemistry Laboratories.

## Compliance with standard methods:

Of those substances being analyzed for, the fluoride, nitrate and chloride determinations are not being done by "Standard Methods." The fluoride determination, like the other two is automated, and does appear acceptable since it makes use of the "Standard Method" procedure and reagents (SPADNS with distillation). The nitrate determination does not make use of a "Standard Method" procedure, but here again it appears acceptable, since in a recent ARS study, the procedure being used (hydrazine reduction with an auto-analyzer) was found to be one of the best.

Because of the number of chemical tests involved, it would appear to be impossible to oversee the performance of each analyst in the determination of each substance as is done in the microbiological survey. If this were to be done, it certainly could not be done in a one or two day visit but in all probability would require a week or more. Furthermore, the value of such a visual performance (in the case of a chemical analysis) is also debatable, as this still would not guarantee that the analyst was obtaining acceptable results. It is, therefore, suggested that laboratory and/or analyst certification be accomplished by requiring each to analyze one or more control samples containing each of the substances listed as of concern in the "Drinking Water Standards of 1962." This was done recently for three of the bureau laboratories, and appears to be a very convenient way of checking a laboratories' performance.

The analysis of control samples will not replace, however, a laboratory visit. In fact, if unacceptable results are obtained by a laboratory in the analysis of any substance in the control sample(s), this in itself may be reason for a visit.

## Conclusions:

The state is not complying with the requirements of the "Public Health Service Drinking Water Standards of 1962" inasmuch as none of the municipal water supplies have been examined routinely (minimum of semi-annually) for chemical contaminates since 1962, except for a few problem supplies. Furthermore, no data from other sources (private, federal or other) apparently are available to indicate that these waters are acceptable.

Additional distilled water storage is needed and a program for routine checking of the quality of the distilled water needs to be inaugurated.

A National Bureau of Standards Thermometer should be purchased for checking thermometers routinely used in analysis and control of water baths, incubators, etc.

Another copy of "Standard Methods" is needed so that both the bacteriology and chemistry laboratories can have copies.

The professional personnel are competent and exhibited a commendable spirit of dedication and cooperation. The turn-over of personnel appears to be rather high, however, because of low salaries.

Since a gas chromatograph is available with an electron capture detector, it would seem desirable to instigate a program of pesticide analysis. It is recognized however, that this would require the addition of another chemist to the staff.

If and when money is available, it was suggested that an atomic absorption spectrophotometer be purchased for heavy metal analysis. Also reagents should be purchased and techniques developed for the analysis of waters for LAS, cyanide, arsenic, etc., which at present can not be done.

Earl F. McFarren
Supervisory Research Chemist

# APPENDIX V

# COPIES OF ENGINEERS FIELD REPORTS FOR EACH SUPPLY

# APPENDIX VI

## METHODS AND PROCEDURES

# APPENDIX VII

## DETAILS OF NON STANDARD METHODS

# GLOSSARY

Back Flow -- The flow of water or other liquids, mixtures, or substances into the distributing pipes of a potable supply of water from any source or sources other than its intended source. Back siphonage is one type of backflow.

Back Flow Connection -- Any arrangement whereby backflow can occur.

Back Siphonage -- The flowing back of used, contaminated, or polluted water from a plumbing fixture or vessel or other sources into a water supply pipe due to a negative pressure in such pipe.

Bad sample -- A bacteriological sample that showed the presence of coliform bacterial contamination.

Consumer -- One person using the water for domestic and culinary purposes.

Cross Connection -- Any physical connection or arrangement between two otherwise separate piping systems, one of which contains potable water and the other either water of unknown or questionable safety, or steam, gas, or chemical, whereby there may be a flow from one system to the other, the direction of flow depending on the pressure differential between the two systems. See Backflow and Back siphonage.

Fecal Coliform Bacteria -- That portion of the total coliform population which are capable of lactose fermentation at an elevated temperature of 44.5°C. Unlike some strains of the non-fecal members of the total coliform group, fecal coliforms have a specific high order of positive correlation with warm-blooded animal pollution, survive for a shorter time in water and soil, and more closely correlate with survival patterns of enteric pathogenic bacteria.

Good Sample-- A bacteriological sample that did not show the presence of coliform bacterial contamination.

Inter-Connection -- A connection between the water supply and one or more additional sources of water not under the jurisdiction or control of the water supply operator.

**Mandatory Limit** -- The upper limit of density of coliform bacteria as described in Section 3.23, as modified below, of the concentration of certain ions as described in Section 5.22 and 5.23 and of radioactivity as described in Section 6.22, Public Health Service Drinking Water Standards, 1962 (PHS Publication No. 956). For these samples collected for this study, the bacterial limit was exceeded if the arithmetic average was more than 1 coliform per 100 ml. Also, for this study the total chromium concentration was considered to be hexavalent chromium.

**Persons Served** -- The aggregate number of consumers.

**Plate Count** --A measure of the general bacterial population present in the water sample as described in Standard Methods for the Examination of Water and Wastewater, 12th Ed. These bacteria will produce colonies on plate count agar in 48 hours when incubated at 35 C. (95 F.).

**Recommended Limit** -- The upper limit of concentration of turbidity, color, chemicals, and radioactivity as described in Sections 4.2, 5.21, and 6.21, PHS Drinking Water Standards 1962 (PHS Publication No. 956).

**Responsible Operator** -- The operator at the treatment plant responsible for the day to day operation of the treatment facilities. Where there is no treatment, the person responsible for the operation of the system.
He is not necessarily the water superintendent.

**Service Connection** -- A physical connection to a water main for the purpose of conveying water to a building or onto a premise for use.

**Standard Metropolitan Statistical Area** -- The boundaries and titles of standard metropolitan statistical areas are established by the Bureau of the Budget with the advice of the Federal Committee on Standard Metropolitan Statistical Areas. This Committee is composed of representatives of the major statistical agencies of the Federal Government. In applying the following criteria, data from the following sources are used by the Committee:

> Population, labor force, density, and occupational data: Bureau of the Census and Bureau of Employment Security.